Cleveland State University
Maxine Goodman Levin College of Urban Affairs

Prepared for:
NASA GLENN RESEARCH CENTER

Prepared by:
Iryna Lendel, Ph.D.
Sunjoo Park

August 2010

The NASA Glenn Research Center:

An Economic Impact Study Fiscal Year 2009

CENTER FOR ECONOMIC DEVELOPMENT

2121 Euclid Avenue Cleveland, Ohio 44115
http://urban.csuohio.edu/economicdevelopment

Acknowledgements

The authors would like to thank Ronald Alexander, Robert Sefcik, Traci Savage, Jean Rogers, employees of the NASA Glenn Research Center, and Chris Blake (Booze Allen Hamilton) for their contribution to this project. They provided management and coordination, data, and feedback on the report's content. This project is truly a result of our teamwork.

The authors of this report also want to recognize the assistance of researchers within the Levin College whose efforts were instrumental to the success of this project. Dr. Ziona Austrian, Director of the Center for Economic Development, offered suggestions throughout the duration of this project and comments to the draft, which added to the value of the final report. Mary Ellen Simon copy-edited the report.

Table of Contents

Executive Summary ..... **i**
Economic Impact Generated by Glenn Research Center Spending i
Glenn Research Center: An Overview ii
A. Introduction **1**
B. NASA Glenn Research Center: Background **2**
B.1 NASA Glenn Test Facilities 2
B.2 Glenn Mission Areas Supporting NASA Themes 3
C. NASA Glenn Research Center: Economic Overview **5**
C.1 Employment and Occupations 5
C.2 Place of Residence for Glenn Employees 7
C.3 Payroll 8
C.4 Glenn Expenditures, FY 2009 9
C.5 Glenn Awards to Academic and Other Institutions 10
C.6 Glenn Revenues 13
C.7 Taxes Paid by Glenn Employees 14
D. Economic Impact of NASA Glenn **15**
D.1 Methodology 15
D.2 Economic Impact on Northeast Ohio in FY 2009 19
D.2.1 Output Impact on Northeast Ohio in FY 2009 19
D.2.2 Employment Impact on Northeast Ohio in FY 2009 23
D.2.3 Labor Income Impact on Northeast Ohio in FY 2009 26
D.2.4 Value Added Impact on Northeast Ohio in FY 2009 30
D.2.5 Tax Impact on Northeast Ohio in FY 2009 34
D.2.6 FY 2009 Northeast Ohio Impact Summary 34
D.3 Economic Impact on the State of Ohio in FY 2009 35
D.3.1 Output Impact on the State of Ohio in FY 2009 35
D.3.2 Employment Impact on the State of Ohio in FY 2009 39
D.3.3 Labor Income Impact on the State of Ohio in FY 2009 42
D.3.4 Value Added Impact on the State of Ohio in FY 2009 45
D.3.5 Tax Impact on the State of Ohio in FY 2009 49
D.3.6 FY 2009 Ohio Impact Summary 49
E. Comparison of NASA Glenn Economic Impacts in FY 2008 and FY 2009 ..... **50**
Appendix A: Data Tables **51**

List of Tables

Table 1. Glenn Civil Service Employment Distribution by Occupational Category, FY 2005-2009 5
Table 2. NASA Glenn On- or Near-Site Contractors' Employment, FY 2005-2009 6
Table 3. Glenn Civil Service Employees by Occupation and Place of Residence, FY 2009 8
Table 4. Glenn Educational Grants in Ohio by Academic Institution
(FY 2006 – FY 2009, in $2009) 12
Table 5. NASA Glenn Revenues, FY 2005 - FY 2009 (millions of nominal dollars) 13
Table 6. Income Taxes Paid by Glenn Employees (in nominal dollars) 14
Table 7. Output Impact Based on Glenn Spending in Northeast Ohio, FY 2009 20
Table 8. Employment Impact Based on Glenn Spending in Northeast Ohio, FY 2009 23
Table 9. Labor Income* Impact Based on Glenn Spending in Northeast Ohio, FY 2009 27
Table 10. Value-Added Impact Based on Glenn Spending in Northeast Ohio, FY 2009 31
Table 11. Output Impact Based on Glenn Spending in the State of Ohio, FY 2009 36
Table 12. Employment Impact Based on Glenn Spending in the State of Ohio, FY 2009 39
Table 13. Labor Income Impact Based on Glenn Spending in the State of Ohio, FY 2009 42
Table 14. Value-Added Impact Based on Glenn Spending in the State of Ohio, FY 2009 46
Table 15. NASA Glenn Economic Impacts, FY 2008- FY 2009 50
Table A.1. Glenn Spending by State, FY 2009 52
Table A.2. Glenn Funding Allocated to Academic Institutions by State, FY 2009 54
Table A.3. NASA Glenn Detailed Expenditures in Northeast Ohio, FY 2009 55
Table A.4. NASA Glenn Detailed Expenditures in the State of Ohio, FY 2009 58

LIST OF FIGURES

Figure 1. Glenn Civil Service Employees by County of Residence, FY 2009 7
Figure 2. NASA Glenn Spending in Select States, FY 2009 9
Figure 3. NASA Glenn Awards to Colleges and Universities, FY 2009 11
Figure 4. Glenn Research Center—Economic Impact on Northeast Ohio, FY 2009 18
Figure 5. Increase in Sales for Select Industries in Glenn-Driven Sectors in Northeast Ohio, FY 2009 22
Figure 6. Increase in Sales for Select Industries in Consumer-Driven Sectors in Northeast Ohio, FY 2009 22
Figure 7. Increase in Jobs for Select Industries in Glenn-Driven Sectors in Northeast Ohio, FY 2009 25
Figure 8. Increase in Jobs for Select Industries in Consumer-Driven Sectors in Northeast Ohio, FY 2009 25
Figure 9. Increase in Labor Income for Select Industries in Glenn-Driven Sectors in Northeast Ohio, FY 2009 29
Figure 10. Increase in Labor Income for Industries in Consumer-Driven Sectors in Northeast Ohio, FY 2009 29
Figure 11. Increase in Value Added for Select Industries in Glenn-Driven Sectors in Northeast Ohio, FY 2009 33
Figure 12. Increase in Value Added for Industries in Consumer-Driven Sectors in Northeast Ohio, FY 2009 33
Figure 13. Increase in Sales for Select Industries in Glenn-Driven Sectors, Ohio, FY 2009 38
Figure 14. Increase in Sales for Select Industries in Consumer-Driven Sectors, Ohio, FY 2009 38
Figure 15. Increase in Jobs for Select Industries in Glenn-Driven Sectors in Ohio, FY 2009 41
Figure 16. Increase in Jobs for Select Industries in Consumer-Driven Sectors in Ohio, FY 2009 41
Figure 17. Increase in Earnings for Select Industries in Glenn-Driven Sectors in Ohio, FY 2009 44
Figure 18. Increase in Earnings for Select Industries in Consumer-Driven Sectors in Ohio, FY 2009 44
Figure 19. Increase in Value Added for Select Industries in Glenn-Driven Sectors in the State of Ohio, FY 2009 48
Figure 20. Increase in Value Added for Industries in Consumer-Driven Sectors in Northeast Ohio, FY 2009 48

EXECUTIVE SUMMARY

- The John H. Glenn Research Center at Lewis Field (Glenn) is one of 10 National Aeronautics and Space Administration (NASA) Centers. Glenn is situated on 350 acres adjacent to Cleveland Hopkins International Airport. Its physical plant includes more than 150 buildings that contain a unique collection of world class test facilities. Glenn also includes the 6,400 acre Plum Brook Station near Sandusky, Ohio, 50 miles west of Cleveland. It specializes in large-scale tests that would be hazardous within the confines of the main campus.
- During the period covered in this report, NASA Glenn was focused on efforts related to all of NASA's missions: Exploration, Science, Space Operations, and Aeronautics Research. Within the Exploration mission, Glenn provided oversight of the Service Module (SM) for the shuttle-replacement vehicle (Orion); oversight of important elements of the Crew Module (CM) project, including building test flight hardware; vital support for the new rocket (Ares) that carries Orion into space; and environmental testing at Plum Brook Station of the entire Orion spacecraft. For the Science mission, among other responsibilities, NASA Glenn manages the In-Space Propulsion Technology Program and development of its associated technologies; management of Radioisotope Power Systems and the development of associated technologies. For the Space Operations mission, NASA Glenn supports the Space Shuttle Program (SSP) by providing expert engineers for the shuttle's electrical power system, its purge, vent, and drain subsystem and for determination of stress, loads, and dynamics on the vehicle; supports the International Space Station; and leads the development of new, advanced communications technology. For the Aeronautics mission, NASA Glenn continues to improve upon its world-class aeronautics heritage by concentrating research and program management efforts on the mastery of the principles of flight in any atmosphere at any speed and the enhancement of aviation safety. For the Fundamental Aeronautics Program, NASA Glenn provides technical project management leadership for the following four projects: Hypersonics Project, Supersonics Project, and Subsonics: Fixed Wing, and Subsonics: Rotary Wing.

- Sections A and B provide an introduction and background for this report, followed by two major sections. Section C is an economic overview of Glenn, including information related to employment and occupations, employee residences, payroll, expenditures, awards to academia and other institutions, revenues, and taxes paid by NASA Glenn employees. Section D provides estimates of the economic impact generated by NASA Glenn for an eight-county Northeast Ohio region and the state of Ohio during FY 2009. The report is an update of earlier studies (published in 1996, May 2000, December 2005, September 2007, September 2008, and August 2009) in which Glenn's FY 1994, FY 1998, FY 2004, FY 2006, FY 2007, and FY 2008 economic impact on Northeast Ohio and the state of Ohio was estimated.

ECONOMIC IMPACT GENERATED BY GLENN RESEARCH CENTER SPENDING

- Economic impact is an analytical approach used to estimate economic benefits generated by an entity for an affected region. It uses an input/output (I-O) model to estimate the effect of NASA Glenn spending on the studied economies. This model measures economic impact in terms

of growth in output (sales), value added (output less intermediary goods), the number of new jobs created, the increase in household earnings, and additional tax revenues. The table below summarizes Glenn's economic impact on Northeast Ohio and the state of Ohio during FY 2009.

Economic Impact	Northeast Ohio	State of Ohio
Output	*$1,213.2 million*	*$1,355.7 million*
Value Added	*$568.2 million*	*$642.1 million*
Employment	*7,017 jobs*	*8,293 jobs*
Labor Income	*$344.4 million*	*$494.8 million*
Taxes	*$87.5 million*	*$102.2 million*

- NASA Glenn activities in Northeast Ohio in FY 2009, stimulated by $763.6 million in revenues primarily from outside the region, generated an increased demand in output (sales) for products and services produced in Northeast Ohio valued at more than $1.2 billion. Value added output increased by $568.2 million as a result of Glenn activities. In addition, 7,017 jobs were created in the region, and households in Northeast Ohio saw labor income increase by $344.4 million. Glenn operations also generated additional $87.5 million in total of local, state, and federal taxes.
- Glenn activities in Ohio in FY 2009, stimulated by $763.6 million in revenues primarily from outside the state, generated an increased demand in output (sales) for products and services produced across the state that were valued at $1,355.7 million. Value added output increased by $642.1 million as a result of Glenn activities. In addition, 8,293 jobs were created in Ohio and households across the state saw labor income increase by $494.8 million. Glenn's activities also generated additional $102.2 million in total of local, state, and federal taxes.
- Industries deriving the most benefit from direct NASA Glenn spending include scientific research and development services, other professional and technical services, colleges and universities, information services, power generation, business and facilities support, and facilities' maintenance and repair.
- Businesses deriving the most benefits from spending by Glenn personnel and other workers, whose earnings are due, in part, to Glenn expenditures, follow typical consumer spending patterns. These include food services, real estate companies, hospitals and healthcare services, motor vehicle dealers, accounting services, commercial banks, and miscellaneous retailers.

GLENN RESEARCH CENTER: AN OVERVIEW

- From FY 2005 to FY 2009, civil service employment fell only slightly, holding onto its valuable labor force. It declined each year between 2005 and 2009, with the total number of employees falling from 1,769 in FY 2005 to 1,650 in FY 2009. This 6.7 % decline is consistent with the overall economic trend of economic stagnation and the current recession that affected Northeast Ohio. From FY 2008 to FY 2009, NASA Glenn's civil service employment fell by 12, from 1,662 to 1,650. The employment number of NASA's on- or near-site contractors increased by 21 from FY 2008 to FY 2009 and declined by 95 from FY 2005 to FY 2009.

- The employees at NASA Glenn are highly educated and highly skilled. In FY 2009, 78% of NASA Glenn's employees attained a bachelor's degree or higher. Specifically, 17% of employees held a doctoral degree, 34% had a master's degree, and 27% possessed a bachelor's degree. Even though NASA Glenn lost some of its employment, it retained the best and brightest and slightly increased the percentage of employees with doctoral and bachelor's degrees.

- Total compensation for NASA Glenn's civil service employees was $213.7 million in FY 2009. The total compensation included payroll that accounted for $172.8 million and employee benefits that accounted for another $40.9 million. Total payroll grew by $7.6 million (4.6%) between FY 2008 and FY 2009, after adjusting for inflation.[1] The average wage per employee grew by 5.3% after adjusting for inflation, from $99,383 in FY 2008 (inflated to 2009 dollars) to $104,707 in FY 2009.

- In 2009, vendors in 50 states (including Ohio) and 12 foreign countries shared the benefits of NASA Glenn's spending of $541.2 million. Compared to the total expenditure of $523.8 million in FY 2008, NASA Glenn increased its expenditures by 3.3% in FY 2009 in nominal dollars. Ohio is the largest beneficiary from NASA Glenn's spending. In FY 2009, Ohio received $326.4 million, which accounted for 60.3% of NASA Glenn's total expenditures; in FY 2009, Ohio received $10.4 million more than in FY 2008 from NASA Glenn. Besides Ohio, five other states (California, Maryland, Oklahoma, Virginia, and Massachusetts) received over $10 million or 2% each of total expenditures during FY 2009. Among foreign countries, the largest beneficiaries were Canada, Puerto Rico, Great Britain, and Germany.

- NASA Glenn's largest expenditures are on scientific research and development including equipment, supplies and materials, grants, and professional services. Spending in Ohio and Northeast Ohio has a significant economic impact on area economies. Of NASA Glenn's expenditures in Ohio, Northeast Ohio received $258 million or 79% of this spending in FY 2009. Northeast Ohio accounted for 47.7% of total NASA Glenn spending in FY 2009, which is 2.3% more than in FY 2008.

- NASA Glenn Research Center provides funding to colleges, universities and other nonprofit institutions in the form of contracts and grants for assisting research and development activities. The amount of Glenn's funding to academia is determined annually based on its goals and mission for each year. In FY 2009, the total of NASA Glenn's academic awards to the colleges and universities in the United States, including Puerto Rico, was $34.8 million in 35 states.

- The University of Toledo has been awarded the highest share of funding in Ohio from NASA Glenn over the last 4 years. They received $2.5 million in FY 2009, which accounted for 31.8% of total awards to colleges and universities in Ohio. The Ohio State University obtained the second largest amount of funding, $2 million (25.6%), from NASA Glenn in FY 2009. Colleges and universities in Northeast Ohio received $2.7 million in FY 2009: University of Akron ($1.2 million), Case Western Reserve University ($0.8 million), Cleveland State University ($0.7 million), and Cuyahoga Community College ($ 10,000).

- NASA Glenn total revenue in FY 2009 reached $763.6 million, which is a 9.2% increase from FY 2008 and a 4.6% increase from FY 2005 without adjusting for inflation. Glenn's total revenue had decreased between 2005 and 2007, but

[1] Total nominal payroll increased by 3.2% between FY2008 and FY2009.

grew steadily thereafter. Glenn's revenue increased 18% from FY 2007 in nominal dollars.

- NASA Glenn continues to be an important economic player in Northeast Ohio and across the state, continually increasing its economic impact on the region and Ohio. NASA Glenn's employees are part of the knowledge-intensive labor force with unique skills on the cutting edge of science and technologies that generate wealth in the region and advance the nation.

A. INTRODUCTION

This report presents an analysis of the economic impact of the National Aeronautics and Space Administration's (NASA) Glenn Research Center (Glenn) on the eight-county Northeast Ohio region and the state of Ohio during fiscal year (FY) 2009.[2] The report also describes some of the NASA Glenn's R&D activities and provides an overview of Glenn. It uses an input/output (I-O) matrix that reflects the buy-sell relationships among industries. The model estimates the effect of Glenn spending on the studied economies. This model assesses economic impact in terms of growth in total output (sales), value added (output less intermediary goods),[3] household earnings, the number of new jobs, and taxes.

The analysis was conducted by the Center for Economic Development at Cleveland State University's Maxine Goodman Levin College of Urban Affairs. This report is an update to previous studies (published in February 1996, May 2000, December 2005, September 2007, September 2008, and August 2009), which estimated Glenn's FY 1994, FY 1998, FY 2004, FY 2006, FY 2007, and FY 2008 economic impact on Northeast Ohio and the state of Ohio. [4]

[2] For purposes of this study, Northeast Ohio includes Ashtabula, Cuyahoga, Geauga, Lake, Lorain, Medina, Portage, and Summit Counties.

[3] Output impact reflects the total value of all additional goods and services produced in the economy. For example, the output economic impact includes the total value of all professional scientific and technical services and all intermediary goods created to secure delivery of the scientific services. Value added impact reflects the value of only additional output produced in the region, which is calculated as total sales less intermediary goods which are not sold as final products. For example, the value added impact will account for the value of all professional scientific and technical services excluding intermediary goods produced to deliver these services. Such intermediary goods, among others, include research supplies, utilities, research services of intermediary steps of research, etc.

[4] Austrian, Z. (1996) *The NASA Lewis Research Center: An Economic Impact Study*. Cleveland State University, Center for Economic Development.
Austrian, Z. & Wolf, A. (2000). *The NASA Glenn Research Center: An Economic Impact Study*. Cleveland State University, Center for Economic Development.
Sadowski, B. (2005). *The NASA Glenn Research Center: An Economic Impact Study, Fiscal Year 2004*. Cleveland State University, Center for Economic Development.
Norton, J. (2007). *The NASA Glenn Research Center: An Economic Impact Study, Fiscal Year 2006*. Cleveland State University, Center for Economic Development.
Lendel, I. (2008). *The NASA Glenn Research Center: An Economic Impact Study, Fiscal Year 2007*. Cleveland State University, Center for Economic Development.
Lendel, I. (2009). *The NASA Glenn Research Center: An Economic Impact Study, Fiscal Year 2007*. Cleveland State University, Center for Economic Development.

B. NASA Glenn Research Center: Background

The NASA Glenn Research Center, in partnership with U.S. industry, universities, and other government institutions, develops critical systems' technologies and capabilities that address national aerospace priorities. The Center is distinguished by a unique blend of aeronautics, space flight, and project management expertise and experience. Its work is focused on technological advances in space flight systems, aeropropulsion, space propulsion, power systems, nuclear systems, communications, and technology to enable human health in space. Its research, technology, and capability development efforts are vital to advancing exploration of our solar system and beyond while maintaining global leadership in aeronautics.

B.1 NASA Glenn Test Facilities

NASA Glenn is located at Lewis Field, a 350-acre site adjacent to Cleveland Hopkins International Airport. Glenn's physical plant includes more than 150 buildings that contain a unique collection of world-class test facilities. Since the groundbreaking for the Aircraft Engine Research Laboratory of the National Advisory Committee for Aeronautics (forerunner to NASA) on January 23, 1941, more than $433 million has been invested in Glenn's physical plant. The estimated replacement cost is approximately $2.0 billion.

NASA Glenn also includes the 6,400-acre Plum Brook Station near Sandusky, Ohio, 50 miles west of Cleveland. It specializes in large-scale tests that would be hazardous within the confines of the main campus. Plum Brook contains the world's largest space environment simulation chamber (100 feet in diameter by 122 feet high). Its large size makes it ideal for testing full-size Mars lander systems and International Space Station hardware. This facility is undergoing a $175 million expansion to add spacecraft vibration and acoustic test capability and will then be used to conduct integrated system-level testing of the new Orion Crew Exploration Vehicle, simulating conditions from launch through insertion into orbit. The total replacement cost of all Plum Brook facilities is approximately $2.0 billion.

B.2 Glenn Mission Areas Supporting NASA Themes

During the period covered in this report, NASA Glenn has several leadership roles that are critical to programs and projects in all of NASA's missions: Exploration, Science, Space Operation, and Aeronautics Research:

Exploration (human spaceflight to the International Space Station (ISS), Moon and Beyond)

- Oversight of the Service Module (SM) for the shuttle-replacement vehicle (Orion). The SM provides power, propulsion, and communications for Orion's Crew Module (CM), where the astronauts reside in flight.
- Oversight of important elements of the CM project including building test flight hardware.
- Vital support for the new rocket (Ares) that carries Orion to space including development of Ares I power and delivery of the Upper Stage Simulator (USS) for the Ares I-X mission, the first planned test flight of the Crew Launch Vehicle.
- Environmental testing at Plum Brook Station of the entire Orion spacecraft.
- Management of several research and advanced technology development projects on the ISS and on Earth, in support of human exploration.

Science

- Management of the In-Space Propulsion Technology Program and development of its associated technologies.
- Management of Radioisotope Power Systems and the development of associated technologies. These develop new ways to power scientific spacecraft including the Advanced Stirling Convertor (ASC) for the Advanced Stirling Radioisotope Generator (ASRG). These systems will allow much longer scientific missions so that more scientific data can be obtained from each mission.

Space Operations

- Supports the Space Shuttle Program (SSP) by providing expert engineers for the shuttle's electrical power system, its purge, vent, and drain subsystem and for determination of stress, loads, and dynamics on the vehicle. The Lead Quality Auditor role for the SSP is also at Glenn.
- Supports the International Space Station by providing the electrical power system management and integration expertise.
- Leads the development of new, advanced communications technology including a demonstration on the International Space Station of software-defined radios.

Aeronautics

NASA Glenn continues to improve upon its world class aeronautics heritage by concentrating research and program management efforts on the mastery of the principles of flight in any atmosphere at any speed and the enhancement of aviation safety. For the Fundamental Aeronautics Program, NASA Glenn provides technical project management leadership for the following four projects:

- Hypersonics Project: Research in propulsion and high temperature materials, instrumentation and dynamic controls to enable very high speed flight, and reliable re-entry into planetary atmospheres.
- Supersonics Project: Scientific leadership in propulsion, combustion, and acoustic research to eliminate environmental (e.g., sonic boom) and performance barriers.
- Subsonics: Fixed Wing: Developing revolutionary technologies and aircraft concepts to achieve highly improved performance (e.g., fuel efficiency) while satisfying strict noise and emission constraints.
- Subsonics: Rotary Wing: Research to improve civilian potential of rotary wing vehicles (helicopters) so that they can carry more payload to farther destinations.

For the Aviation Safety Program, NASA Glenn plays a key roles in conducting long-term, cutting-edge research that will produce tools, methods, concepts, and technologies to improve the intrinsic safety features of aircraft engines, both current and future, including studies of the safety of aging aircraft, especially important because aircraft remain in service for the military and industry for long periods of time.

C. NASA Glenn Research Center: Economic Overview

This section presents a description of the NASA Glenn Research Center during FY 2009. We describe changes that occurred in employment and occupations, workers' places of residence, payroll, expenditures, awards to academia and other institutions, revenues, and taxes paid by Glenn employees. This report includes data from FY 2005 to FY 2009.

C.1 Employment and Occupations

The labor force of NASA Glenn consists of two components: civil service employees and local contractors. This is common in federal labs because contracted employees provide necessary flexibility to the labor force. While hiring civil servants is more complex and lengthy, the number of contracted employees can be easily adjusted depending on the needs of research labs.

Table 1 shows NASA Glenn's civil service employment by year and occupational categories between FY 2005 and FY 2009 not including local contractors. The total number of civil service employees at NASA Glenn in FY 2009 was 1,650 which decreased by 12 from FY 2008. Civil service employment peaked in FY 2005 at a total of 1,769, decreasing slightly each year between FY 2005 and FY 2009. This change constitutes a 6.7% decline between FY 2005 and FY 2009, and only a 0.7% decline in FY 2009 compared to FY 2008. These changes are consistent with the overall employment decline in Northeast Ohio, which was hit hard by the last recession and has not recovered yet.

Table 1. Glenn Civil Service Employment Distribution by Occupational Category, FY 2005-2009

Fiscal Year	Total	Occupational Category			
		Administrative Professional	Clerical	Scientists & Engineers	Technician
2005	1,769	21%	6%	58%	15%
2006	1,678	21%	5%	60%	14%
2007	1,672	21%	5%	60%	14%
2008	1,662	21%	5%	61%	12%
2009	1,650	20%	4%	63%	12%

Glenn's total employment figures, shown in Table 1, do not include employees who work for NASA Glenn's local prime contractors.[5]

Civil service employment at NASA Glenn is categorized into four occupational groups: administrative professional, clerical, scientists and engineers, and technicians. The occupational structure of NASA Glenn's employment is almost constant during the analyzed period. The largest occupational category is that of scientists and engineers which accounts for 63% of the civil service

[5] A detailed listing of Glenn's local contractors is at http://www.grc.nasa.gov/WWW/Procure/ContractorList/On-siteServiceContractorListing.htm

employees in FY 2009. The administrative professional category accounts for 20% of the total, technicians are 12%, and clerical employees are the remaining 4% of civil service employees.

The average percentage of scientists and engineers in civil service employment during the analyzed period is 60%; this number has gradually increased from 58% in FY 2005 to 63% in FY 2009. Comparing FY 2008 to FY 2009, this category grew by 2%, which indicates that NASA Glenn had an additional 26 scientists and engineers in FY 2009. Although the total civil service employment numbers at NASA Glenn has decreased from FY 2005 to FY 2009, the number of scientists and engineers has gradually grown from 1,007 in FY 2005 to 1,040 in FY 2009.

The increase of the share of scientists and engineers was accompanied by the loss of technicians over 5 years. The share of technicians decreased from 15% in FY 2005 to 12% in FY 2009, which is equal to the loss of 74 employees. Clerical staff also decreased during the same period, accounting for the loss of 31 employees between FY 2005 and FY 2009.

Although administrative professionals held its occupational share at 20% to 21%, the absolute number of administrative professionals was reduced by 34 employees from FY 2005 to FY 2009.

The employees at NASA Glenn are highly educated and highly skilled. In FY 2009, 78% of NASA Glenn's employees held a bachelor's degree or higher. Specifically, 17% of all employees held a doctoral degree, 34% had a master's degree, and 27% possessed a bachelor's degree. Even though NASA Glenn lost some of its employment, it retained highly skilled professionals and slightly increased the percentage of employment with bachelor's degrees.

Total employment at NASA Glenn showed an increase of 9 employees from FY 2008 to FY 2009, accounting for both civil sector employment and on- or near-site contractors. Even though the civil sector employment fell slightly between FY 2008 and FY 2009 (by 12 employees), the on- or near-site employment increased by 21 during the same period of time. NASA Glenn's on- or near-site employment has grown annually since 2006 (Table 2).

Table 2. NASA Glenn On- or Near-Site Contractors' Employment, FY 2005-2009

Fiscal Year	Employment of on- or near-site contractors
2005	1,800
2006	1,450
2007	1,755
2008	1,874
2009	1,895

C.2 Place of Residence for Glenn Employees

NASA Glenn is located near Cleveland Hopkins International Airport in Cuyahoga County, Northeast Ohio. Glenn also includes Plum Brook Station near Sandusky, Ohio, west of Northeast Ohio. Most Glenn civil service employees live in Cuyahoga County and surrounding counties. The vast majority of civil service employees (95.7%) at NASA Glenn live in Northeast Ohio. Specifically, 60.4% of civil servants live in Cuyahoga County where Glenn is located. A significant number of employees live in Lorain (15.2%), Medina (12.8%), Summit Counties (3.7%), and in counties southwest of Cuyahoga County (Figure 1).

Figure 1. Glenn Civil Service Employees by County of Residence, FY 2009

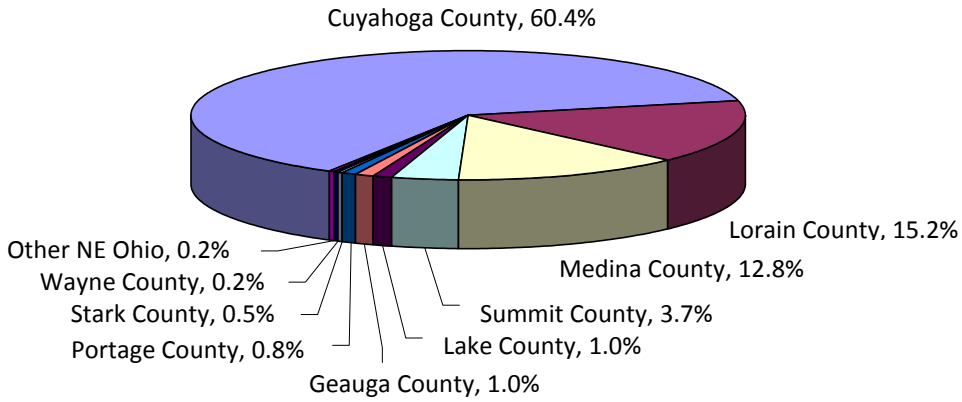


Table 3 shows the places of residence of Glenn civil service employees by their occupations. There is not a significant variation between occupational groups in places of residence. Over 95% of the employees in each occupational category live in Northeast Ohio, and Cuyahoga County captures more than 50%, the highest share in places of residence of employees in each occupational category within Northeast Ohio.

Table 3. Glenn Civil Service Employees by Occupation and Place of Residence, FY 2009

Residence	Administrative Professional	Clerical	Scientists & Engineers	Technicians	Total
Northeast Ohio	96.3%	95.7%	95.0%	98.9%	95.7%
Cuyahoga County	60.1%	56.5%	61.7%	54.7%	60.4%
Lorain County	16.2%	26.1%	13.5%	19.9%	15.2%
Medina County	13.1%	6.5%	12.3%	16.6%	12.8%
Summit County	5.4%	0.0%	3.6%	1.7%	3.7%
Lake County	0.9%	2.2%	0.9%	1.1%	1.0%
Geauga County	0.0%	2.2%	1.1%	1.7%	1.0%
Portage County	0.0%	0.0%	0.9%	1.7%	0.8%
Stark County	0.3%	0.0%	0.5%	1.1%	0.5%
Wayne County	0.3%	0.0%	0.2%	0.0%	0.2%
Other NE Ohio	0.0%	2.2%	0.2%	0.6%	0.2%
Other Ohio	2.6%	4.3%	1.7%	1.1%	1.9%
Out of State	1.1%	0.0%	3.4%	0.0%	2.4%

C.3 PAYROLL

Total compensation for NASA Glenn's civil service employees was $213.7 million in FY 2009. The total compensation included payroll that accounted for $172.8 million and employee benefits that accounted for another $40.9 million. Total payroll grew by $7.6 million (4.6%) between FY 2008 and FY 2009 after adjusting for inflation.[6] The average wage per employee grew by 5.3% after adjusting for inflation, from $99,383 in FY 2008 (inflated to 2009 dollars) to $104,707 in FY 2009.[7]

Compared to FY 2004,[8] in real dollars adjusted for inflation, total compensation fell by 2.6%, including a salary decline of 3.6% and an increase in benefits of 1.9%. This can be counted as a very small decline considering the loss of 295 employees (15.2%) during this same time period. Civil service employment decreased from 1,945 in 2004 to 1,650 workers in 2009. During the same period, the average wage per Glenn employee increased from $92,047 in FY 2004 to $104,707 in FY 2009 after adjusting for inflation.[9]

[6] Total nominal payroll increased by 3.2% between FY2008 and FY2009.

[7] Average wage per employee in nominal terms increased by 3.9% between FY 2008 and FY 2009.

[8] FY 2005 data were not available for comparison.

[9] In real dollars, the average employee wage rose from $83,366 to $104,707, which accounts for 25.6% or about 5% per year.

C.4 GLENN EXPENDITURES, FY 2009

In 2009, vendors in 50 states (including Ohio) and 12 foreign countries shared the benefits of NASA Glenn's spending of $541.2 million. Compared to the total expenditure of $523.8 million in FY 2008, NASA Glenn increased its expenditures by 3.3% in FY 2009 in nominal dollars.

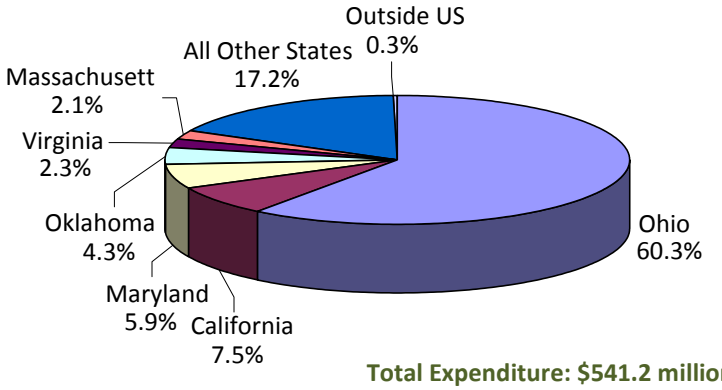
Figure 2 shows the geographical distribution of NASA Glenn's spending in FY 2009, of which Ohio is the largest beneficiary. In FY 2009, Ohio received $326.4 million, accounting for 60.3% of Glenn's total expenditure. The share of Glenn's expenditures in Ohio is similar to that of FY 2008, but in FY 2009 Ohio received $10.4 million more from NASA Glenn than in FY 2008.

In addition to the state of Ohio, all other states received $213.3 million in FY 2009 (39.4% of the total NASA Glenn spending in FY 2009), and foreign countries (including Puerto Rico) received $1.4 million (or 0.3% of total spending) (See Appendix A.1).

Besides Ohio, five other states (California, Maryland, Oklahoma, Virginia, and Massachusetts) received over $10 million or at least 2% each of total expenditure during FY 2009. California is the second largest beneficiary from NASA Glenn's spending, receiving $40.8 million which accounted for 7.5% of Glenn's total expenditure in FY 2009. Compared to FY 2008, Glenn increased its expenditures in California by $10.4 million which is 34.4% more than in FY 2008 in nominal dollars. At the same time, NASA Glenn significantly decreased its spending in New York. In FY 2009, the state of New York received $8.9 million in comparison to $16.2 million in FY 2008, which is a 45% reduction in nominal dollars.

Among foreign countries, the largest beneficiaries were Canada, Puerto Rico, Great Britain, and Germany.

Figure 2. NASA Glenn Spending in Select States, FY 2009



Total Expenditure: $541.2 million

NASA Glenn makes its largest expenditures on scientific research and development services, including equipment, supplies and materials, grants, and professional services. The spending made in Ohio and Northeast Ohio produces significant economic impact on these economies.

Within Ohio's expenditures, Northeast Ohio received $258 million or 79% of this spending in FY 2009. Northeast Ohio accounted for 47.7% of total NASA Glenn spending in FY 2009, which is 2.3% more than in FY 2008.

C.5 Glenn Awards to Academic and Other Institutions

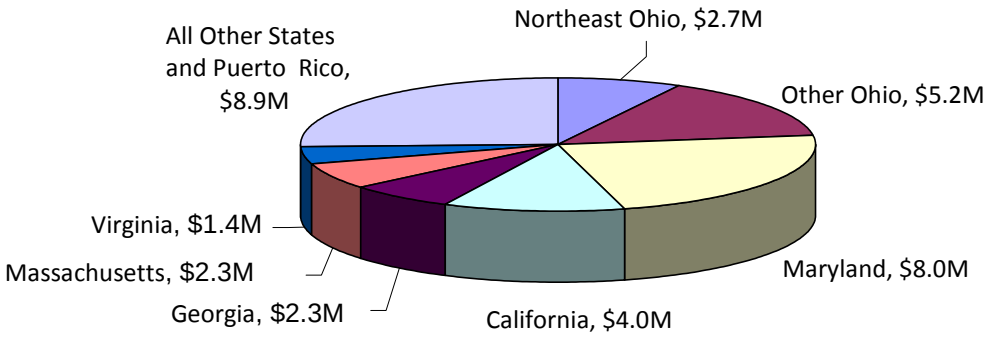
NASA Glenn Research Center provides funding to colleges, universities and other nonprofit institutions in the form of R&D contracts and grants for assisting research and development activities. The amount of Glenn's funding to academia is determined annually based on its goals and mission of each year.

In FY 2009, the total of NASA Glenn's academic awards to colleges and universities in the United States, including Puerto Rico, was $34.8 million in 35 states and a territory. This constitutes a $19 million decrease (35%) from FY 2008 in nominal dollars.

Maryland received the largest share of Glenn awards to colleges and universities in FY 2009, accounting for 23% ($7.99 million). The colleges and universities in the state of Ohio received $7.96 million of funding from NASA Glenn in FY 2009, accounting for 22.9% of the total. While the total amount of NASA Glenn's awards to academia decreased between FY 2008 and FY 2009, the share that Ohio received increased from 18.9% to 23.2% in nominal dollars. California received almost $4 million and Georgia, Massachusetts, and Virginia each received more than $1 million in Glenn awards to their colleges and universities during FY 2009 (See Appendix Table A.2).

Figure 3 shows the distribution of funding awarded to colleges and universities in selected states. Academic institutions in Northeast Ohio received $2.7 million which accounted for 34.4% of Ohio university grants received in FY 2009. This constitutes a decrease by $2.7 million from $5.4 million in FY 2008 in nominal dollars. Colleges and universities in other Ohio regions, however, received from NASA Glenn increased amounts of funding, i.e., $5.2 million in FY 2009 compared to $4.8 million in FY 2008, in nominal dollars.

Figure 3. NASA Glenn Awards to Colleges and Universities, FY 2009



Total Academic Awards: $34.8 million

Table 4 shows the distribution of Glenn awards by college and university in the state of Ohio for FY 2006, FY 2007, FY 2008, and FY 2009 in adjusted 2009 dollars: $7.96 million in educational grants was awarded to academic institutions in Ohio in FY 2009, $2.1 million less than in FY 2008 when awards totaled $10 million. In 2009 dollars, educational grants were reduced by 50% compared to $15.9 million in FY 2006.

The University of Toledo has been awarded the highest share of funding from NASA Glenn over the last 4 years. They received $2.5 million in FY 2009, which accounted for 31.8% of total awards to colleges and universities in Ohio. Ohio State University obtained the second largest amount of funding, $2 million (25.6%), from NASA Glenn in FY 2009. Colleges and universities in Northeast Ohio received $2.7 million in FY 2009: University of Akron ($1.2 million), Case Western Reserve University ($0.8 million), Cleveland State University ($0.7 million), and Cuyahoga Community College ($10,000).

Table 4. Glenn Educational Grants in Ohio by Academic Institution (FY 2006 – FY 2009, in $2009)

OHIO COLLEGES & UNIVERSITIES	FY 2006	FY 2007	FY 2008	FY 2009*	2009 SHARE
University of Toledo	$4,955,113	$3,850,613	$3,366,511	$2,531,493	31.8%
Ohio State University	$3,713,738	$2,017,032	$1,791,518	$2,036,646	25.6%
University of Akron	$837,156	$553,836	$1,110,617	$1,218,771	15.3%
Case Western Reserve University	$3,251,140	$2,245,506	$1,613,143	$795,566	10.0%
Cleveland State University	$2,359,315	$1,646,257	$1,452,718	$712,238	8.9%
University of Cincinnati	$77,764	$180,546	$611,496	$483,572	6.1%
Ohio University	$120,644	$37,711	$54,045	$68,267	0.9%
University of Dayton	$159,474	$12,853		$47,940	0.6%
Wright State University	$81,948	$45,608	$479	$32,258	0.4%
Bowling Green State University	$299,957	$31,741		$28,136	0.4%
Cuyahoga Community College	$38,210	$565	$35,507	$10,000	0.1%
Kent State University	$12,788	$2,375			
John Carroll University		($10,243)			
Lake County Community College					
Baldwin Wallace College	$20,676				
Myers University	$6,723				
Lorain County Community College	$1,233				
Malone College	$672				
Capital University	($84)				
TOTAL	**$15,936,465**	**$10,614,399**	**$10,036,034**	**$7,964,886**	**100.0%**

** Table is sorted by this column.*

C.6 Glenn Revenues

Total revenue in FY 2009 reached $763.6 million, which is a 9.2% increase from FY 2008 and a 4.6% increase from FY 2005 without adjustment for inflation. Glenn's total revenue had decreased for years between 2005 and 2007, but has grown steadily thereafter. Glenn's revenue has increased 18% from FY 2007 in nominal dollars.

Table 4 shows NASA Glenn revenue from FY 2005 to FY 2009 by revenue sources. Glenn's revenue comes from two sources: NASA direct authority and reimbursable commitments. Both revenue components have followed the same trend as total revenue, declining between FY 2005 and FY 2007 and growing since then.

The share of NASA direct authority in total revenue fluctuated above 90%, being the lowest in FY 2006 (93%) and highest in FY 07 (96.9%). Average share of the funds directly authorized by NASA out of total revenue is 95.6% between FY 2005 and FY 2009. In FY 2009, Glenn received $763.6 million in revenue from NASA and this accounted for 95.7% of the total revenue. NASA Glenn also received an additional $32.6 million from reimbursable commitments.

Table 5. NASA Glenn Revenues, FY 2005 - FY 2009 (millions of nominal dollars)

Revenue Source	FY05	FY06	FY07	FY08	FY09
NASA Direct Authority	$704.5	$669.6	$626.9	$671.7	$731.0
Reimbursable Commitments	$25.3	$50.2	$20.2	$27.9	$32.6
Total FY Authority	$729.8	$719.8	$647.1	$699.5	$763.6
Revenue from NASA	96.5%	93.0%	96.9%	96.0%	95.7%

Glenn's revenue from other sources besides NASA has increased by $ 4.7 million, 16.9% from FY 2008 to FY 2009 in nominal dollars. This is because reimbursable commitments from other federal agencies and non-federal entities significantly increased compared to FY 2008, even though the Department of Defense decreased its funding. During the FY 2009, the structure of reimbursable commitments included: other federal agencies (68.5%), domestic, non-federal entities (25.4%), and the Department of Defense (6.1%).

C.7 Taxes Paid by Glenn Employees

State and local taxes paid directly to state and local entities by NASA Glenn employees are important to the regional economies of Northeast Ohio and Ohio. The amount of taxes paid by Glenn employees is determined by the number and earnings of employees whose workplaces are located on the Glenn campus. Most of the Glenn employees work in the city of Brook Park and other facilities are located in the cities of Cleveland and Fairview Park which affects the distribution of their tax dollars.

Table 6 shows the amount of income taxes withheld from Glenn employee paychecks and sent directly to state and local governments. This excludes taxes paid by employees to local governments based on their place of residence. The total amount of income taxes from Glenn's employees is $9,435,588 in FY 2009. The state of Ohio and the city of Brook Park are the two largest beneficiaries of the income taxes paid by NASA Glenn's employees. The state of Ohio received 65% of total taxes paid by Glenn's employees and the city of Brook Park received 31% of the total taxes, which together accounted for 88% of local income taxes paid by NASA Glenn employees in FY 2009. Over the past 5 years, Glenn employees paid $31.2 million to the state of Ohio and $15.7 million to local governments.

However, the annual state and local taxes paid by Glenn employees decreased by 1.5% in nominal dollars between FY 2005 and FY 2009. This is because the amount of taxes in the state of Ohio and the city of Fairview Park decreased compared to FY 2005, although the income taxes from Glenn to the city of Brook Park and the city of Cleveland kept increasing. Taxes paid to the city of Cleveland increased significantly the second year in a row, even though the share of these taxes in total Glenn income tax amount paid is not significant (0.1%).

Table 6. Income Taxes Paid by Glenn Employees (in nominal dollars)

Year	City of Brook Park	City of Cleveland	City of Fairview Park	State of Ohio	Total
2005	$2,625,474	$2,311	$336,740	$6,613,854	$9,578,379
2006	$2,600,094	$2,433	$386,722	$6,205,963	$9,195,211
2007	$2,748,507	$2,362	$389,630	$6,097,704	$9,238,203
2008	$2,844,033	$6,910	$399,634	$6,189,703	$9,440,279
2009	$2,941,876	$9,174	$385,752	$6,098,786	$9,435,588

D. Economic Impact of NASA Glenn

In this section we discuss the economic impact of the NASA Glenn Research Center on Northeast Ohio[10] and the state of Ohio in FY 2009. Total impact is measured in terms of output (sales), employment, value added, household earnings, and taxes contributed to local, state, and federal budgets. Each of these categories (except for taxes) is estimated as the sum of four components: change in final demand, direct impact, indirect impact, and induced impact. Glenn's total impact on Northeast Ohio and the state of Ohio are estimated separately.

D.1 Methodology

Total economic impact is estimated based on the assumption that an enterprise (in this case, NASA Glenn) comes into existence in one day and generates a demand for goods and services needed for its operation. The demand reflects the investment NASA Glenn generates in Northeast Ohio and Ohio economies. The increase in demand from NASA's investments in the region generates economic impact (on Northeast Ohio or Ohio) that can be quantified by including the change of final demand in a statistical model.[11] The effects of a change in final demand is traced throughout the Northeast Ohio or Ohio economy using an input-output model that captures the buy-sell relationships among all industry sectors and the household sector in relevant economy.

In order for Glenn to engage in research and development, other goods and services are needed as intermediate inputs. This leads to the generation of other components of economic impact: direct, indirect, and induced. Changes in final demand also include initial first-round effects. For the assessment of output impact, the initial first-round effects consist of total spending by NASA Glenn, value added, and household income (total payroll of Glenn's employees), and employment (total employment of NASA Glenn in given year) for this estimation in FY 2009.

Direct impact refers to the initial value of goods and services, including labor, purchased by Glenn to conduct its operations within Northeast Ohio or the state of Ohio.[12] Indirect impact measures the value of labor, capital, and other inputs of production needed to produce the goods and services required by Glenn. Induced impact measures the change in spending by local households due to increased earnings by employees in local industries who produce goods and services for Glenn and its suppliers.

Economic impact analysis takes into account inter-industry buy-sell relationships within the economy. These relationships largely determine how the economy responds to changes in economic activity. Input-output (I-O) models estimate inter-industry relationships in a county, region, state, or country by measuring the industrial distribution of inputs purchased and outputs sold by each industry and the household sector. Thus, by using I-O models, it is possible to estimate how the impact of one additional dollar or one job ripples through the respective economy, creating additional expenditures and jobs. The economic multiplier measures the ripple effect that an initial expenditure has on the local

[10] For the purposes of this analysis, Northeast Ohio is limited to the Akron and Cleveland metropolitan areas and includes Ashtabula, Cuyahoga, Geauga, Lake, Lorain, Medina, Portage, and Summit Counties.

[11] Change in final demand is defined as the purchases of goods and services for NASA Glenn's final consumption.

[12] For NASA Glenn it is a first-order indirect effect.

economy.[13] This study utilizes regional I-O multipliers from the IMPLAN Professional model.[14]

Two factors need to be addressed when estimating economic impact: (1) purchases from companies located outside the studied region need to be excluded, and (2) the share of revenues received from local sources needs to be considered. For this analysis, economic impact on the Northeast Ohio economy is generated only by Glenn purchases from companies located within Northeast Ohio; economic impact on the state of Ohio is generated only by Glenn purchases from companies located throughout the state of Ohio. Therefore, when estimating the impact on Northeast Ohio, goods and services purchased from businesses and other entities located outside the eight-county region were excluded from the model. Likewise, when estimating the impact on the state of Ohio, all goods and services purchased within Ohio are included and goods and services purchased from businesses and other entities located outside the state were excluded from the respective model. Regarding sources of revenues, all of Glenn's revenues are received from non-local sources (federal sources) and, therefore, no further adjustments are required.

Before entering local (Northeast Ohio or the state of Ohio) expenditures into the IMPLAN model, the amounts are discounted by the percentage of revenues that are received from local sources. If expenditures were not discounted by the percentage of revenues coming from local sources, sometimes referred to as "neutral monies" that reflect a substitution effect, then the economic impact values would simply reflect the redistribution of local funds. The objective of impact analysis is to estimate the effect of monies coming from outside the studied economy rather than the redistribution of monies already existing in that economy. Revenues coming from outside the respective economy are sometimes referred to as "good money." Since almost all Glenn revenues are derived from federal sources (95.7%),[15] discounting of expenditures due to local revenues was not necessary.

The economic impact is measured in terms of five variables: employment, labor income, value added, output, and taxes:

- Employment impact measures the number of additional jobs created in the region as a result of NASA Glenn expenditures.
- Labor income impact measures the additional household earnings created in the region due to NASA Glenn expenditures.
- Value-added impact measures the additional value-added output created in the region as a result of NASA Glenn expenditures. Value- added is output less the value of intermediary goods.[16]
- Output impact measures the additional value of goods and services produced in

[13] For example, suppose that company XYZ reports sales of $1 million. From the revenues, the company pays its suppliers and workers, covers production costs, and takes a profit. Once the suppliers and employees receive their payments, they will spend a portion of their money in the local economy purchasing goods and services, while another portion of the monies will be spent outside the local economy (leakage). By evaluating the chain of local purchases that result from the initial infusion of $1 million, it is possible to estimate a regional economic multiplier.

[14] IMPLAN was originally developed by two federal agencies, the Department of Agriculture and the Department of the Interior, to assist in land and resource management planning. The model was later commercialized by the Minnesota IMPLAN Group, Inc. as a software package.

[15] This includes revenue from NASA and other federal agencies.

[16] Intermediary goods and services—such as energy, materials, and purchased services—are purchased for the production of other goods and services rather than for final consumption.

the region as a result of NASA Glenn expenditures.

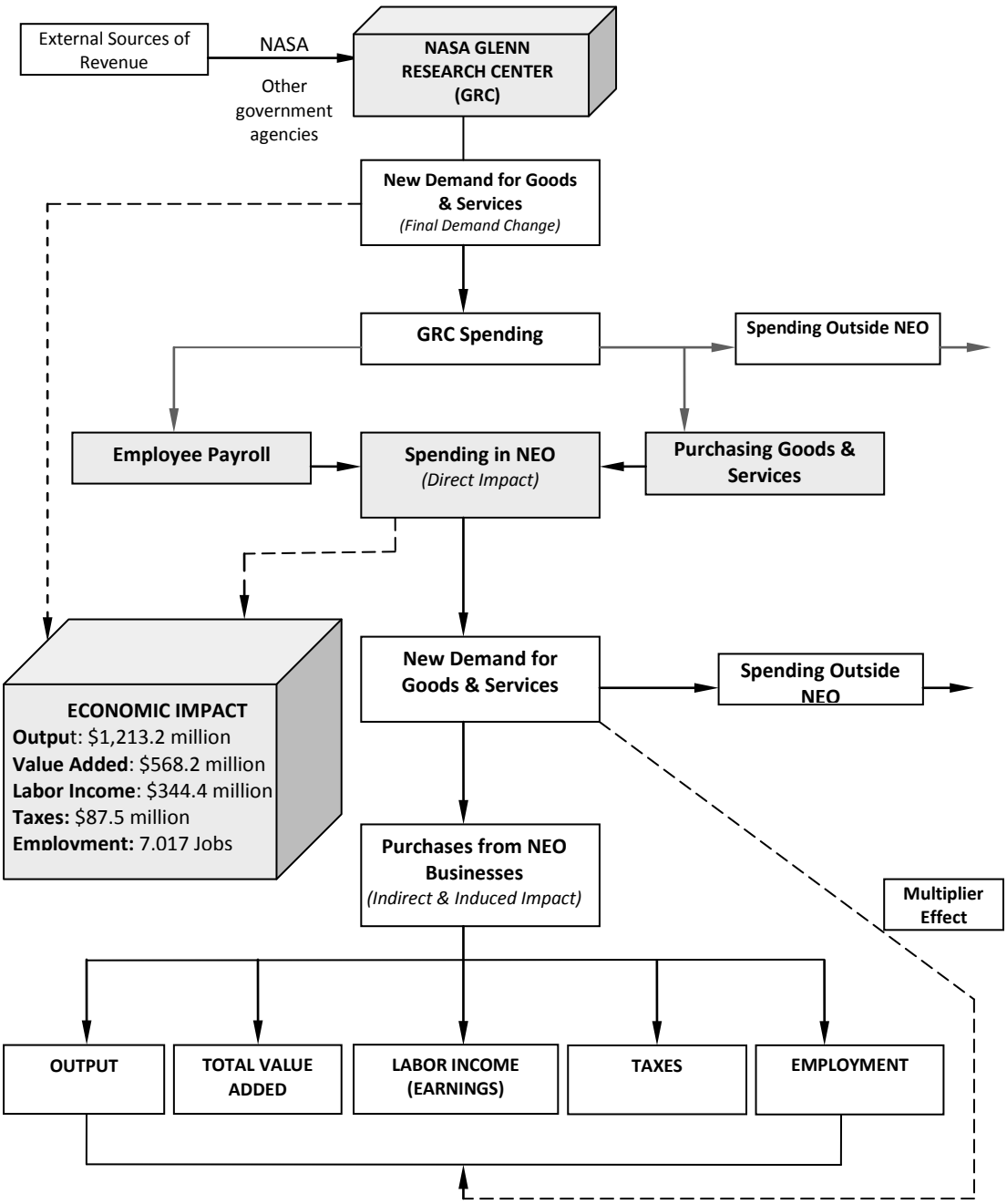
- Tax impact measures the additional federal, state, and local tax revenues collected in the region as a result of NASA Glenn expenditures.

The employment, labor income, value- added and output impacts are each a summation of three impacts: direct impact, indirect impact, and induced impact. [17]

Figure 4 illustrates the process by which NASA Glenn impacted the local economy through its spending in the Akron and Cleveland metro areas in FY 2009. Through its attraction of federal dollars, Glenn creates new demand for goods and services (final demand change). Some of this demand is generated for goods and services provided by vendors outside the Akron-Cleveland metro areas, resulting in dollars leaking from the local economy. However, many goods and services are purchased locally.

[17] The summation of direct, indirect, and induced impacts to the total impact across the lines of industries in the impact tables in the next few pages (tables 7-14) may reflect rounding discrepancies created by multiple iterations of IMPLAN modeling.

Figure 4. Glenn Research Center—Economic Impact on Northeast Ohio, FY 2009



D.2 Economic Impact on Northeast Ohio in FY 2009

In this section, we discuss the economic impact that NASA Glenn spending produced for the Northeast Ohio economy in FY 2009. More specifically, we present a detailed analysis of the change in output (sales), value added, labor income (earnings), taxes, and employment generated by Glenn activities.

D.2.1 Output Impact on Northeast Ohio in FY 2009

This analysis uses SAM multipliers to estimate the ripple effect that an initial expenditure has on a local economy. [18] These multipliers measure the effect of NASA Glenn spending on output (sales) in Northeast Ohio. They provide a quantitative measure of the total change in output produced by Northeast Ohio industries for each additional final demand dollar expended by Glenn.

NASA Glenn expenditures were divided into spending for goods and services purchased from companies and other entities (such as universities) located in Northeast Ohio (local) and spending for goods and services from businesses and other entities located outside of Northeast Ohio. Local spending is then categorized by industry, based upon an IMPLAN industry classification system that is analogous to the North American Industry Classification System (NAICS). Table A.3, Appendix A, provides a detailed Glenn expenditure list by specific industry.

Table 7 presents the total output impact and its components. Local Glenn expenditures represent direct output impact. Indirect impact is estimated by summing the contributions of individual industries that provide inputs to the producers of the goods and services ultimately consumed by Glenn. Induced impact is estimated by measuring the spending of workers who are employed as a result of the demand for products and services created by Glenn. Total output impact is the sum of change in final demand, direct impact, indirect impact, and induced impact. Table 7 reports output impacts by industry sector and shows how Glenn spending across Northeast Ohio affects all sectors of the economy.

[18] IMPLAN type SAM multipliers are used in this study. SAM multipliers are based on information in a social account matrix that considers social security and income tax leakage, institution savings, commuting, and inter-institutional transfers.

Table 7. Output* Impact Based on Glenn Spending in Northeast Ohio, FY 2009

NASA Glenn Expenditures in Northeast Ohio: $441,751,294

Industry	Direct	Indirect	Induced	Total**
Agriculture, forestry, fishing & hunting	$0	$152,817	$389,443	$542,260
Mining	$0	$1,036,128	$531,007	$1,567,135
Utilities	$19,407,905	$1,780,722	$5,358,101	$26,546,728
Construction	$33,860,472	$2,450,331	$1,982,257	$38,293,062
Manufacturing	$1,582,365	$5,126,975	$10,804,290	$17,513,630
Wholesale trade	$5,664	$3,277,680	$18,044,544	$21,327,890
Retail trade	$753,728	$1,609,728	$38,317,856	$40,681,311
Transportation & warehousing	$57,757	$5,170,407	$6,770,072	$11,998,235
Information	$15,266,887	$10,963,319	$13,271,027	$39,501,233
Finance & insurance	$0	$9,542,907	$42,013,829	$51,556,735
Real estate & rental	$422,691	$10,110,248	$63,001,113	$73,534,054
Professional- scientific & tech services	$136,623,623	$24,544,106	$15,341,346	$176,509,079
Management of companies	$0	$2,845,083	$3,195,260	$6,040,343
Administrative & waste services	$40,840,077	$13,205,984	$8,222,375	$62,268,436
Educational services	$3,549,597	$39,446	$5,513,365	$9,102,408
Health & social services	$1,320,614	$52,634	$46,189,674	$47,562,922
Arts- entertainment & recreation	$0	$504,208	$5,054,780	$5,558,988
Accommodation & food services	$0	$2,955,609	$15,323,622	$18,279,231
Other services	$23,665	$3,522,386	$13,239,582	$16,785,633
Government & non NAICS	$259	$1,797,854	$5,050,231	$6,848,345
TOTAL	$253,715,305	$100,688,571	$317,613,774	$672,017,658
Change in final demand*	$541,159,506			
Direct impact	$253,715,305			
Indirect impact	$100,688,571			
Induced impact	$317,613,774			
Total output impact	**$1,213,177,156**			

**For output impact, the change in final demand equals to spending by Glenn within and outside Northeast Ohio excluding payroll and health benefits.*
***Total does not add up to "Direct + Indirect + Induced" because of rounding.*

The total output impact across Northeast Ohio as a result of Glenn Research Center FY 2009 activities was $1.213 billion. Glenn's expenditures of $442 million in Northeast Ohio resulted in a change in output (sales) of $672 million across all industry sectors (Table 7). For example, Glenn spending affected a $17.5 million increase in sales (direct, indirect, and induced impacts) by all manufacturing-related industries. Thus, the impact of Glenn's presence in the area is represented as the increase in output in comparison to the hypothetical absence of Glenn in Northeast Ohio.

Of the total output impact, 45% ($541 million) is accounted for by the change in final demand that occurs because Glenn operations bring resources into Northeast Ohio from outside the region. Approximately $254 million (21%) of the total output impact is a result of direct spending by Glenn for goods and services purchased within Northeast Ohio. The remaining output impact of $418 million (34%) is attributable to the indirect and induced components as Glenn spending ripples through the economy.

A detailed analysis of IMPLAN model results indicates that the $672 million change in output (sales) generated by the direct, indirect, and induced impacts can be divided into three broad categories—Glenn-driven sectors, consumer-driven sectors, and other sectors. Glenn-driven sectors are those industry groups whose increased sales, employment, and earnings are attributed primarily but not exclusively to Glenn spending. They include utilities, construction, information, professional and scientific services, administrative and support services, and education. The total increase in output for these sectors in FY 2009 was $352.2 million or 52.4% of the total impact generated by the direct, indirect, and induced impacts.

Consumer-driven sectors are those industry groups whose increased sales, employment, and earnings are attributed primarily to spending by Glenn employees and other workers who produce goods and services for Glenn and their suppliers. They include retail, finance and insurance, real estate, healthcare, entertainment and food, other services, and owner-occupied buildings.[19] The total increase in output for these sectors in FY 2009 was $254 million or 37.8% of the total impact.

Other sectors are those industry groups that are driven by both Glenn and consumer spending or whose impact is less significant. They include manufacturing, government enterprises, agriculture, mining, wholesale trade, and transportation and warehousing.

The output distribution for select industries within the Glenn-driven sectors is shown in Figure 5 and the output distribution for select industries within the consumer-driven sectors is presented in Figure 6. Industries with additional sales of at least $5 million were selected to be presented in Figures 5 and 6.

The Scientific Research and Development Services industry generates the largest impact of output; it increased by $102 million in FY 2009 due to Glenn's operations (Figure 5). This amount is the summation of the direct, indirect, and induced impacts generated primarily but not exclusively by

[19] *Owner-occupied dwellings* is a special industry sector developed by the Bureau of Economic Analysis. It estimates what owner/occupants would pay in rent if they rented rather than owned their homes. This sector creates an industry out of owning a home. Its sole product (or output) is ownership, purchased entirely by personal consumption expenditures. Owner-occupied dwellings capture the expenses of home ownership such as repair and maintenance construction, various closing costs, and other expenditures related to the upkeep of the space in the same way expenses are captured for rental properties.

Glenn spending for research services. The increase of $102 million accounts for 29% of the $352.2 million increase in output for all industries within the Glenn-driven sectors. Other industries shown in Figure 5 can be interpreted in a similar manner.

The food services industry saw an increase in sales of $18.2 million in FY 2009 (Figure 6). This amount is the summation of the direct, indirect, and induced impacts generated primarily by Glenn employees and other workers for food and drink. The increase of $18.2 million accounts for 7.1% of the $254 million increase in output for all industries within the consumer-driven sectors.

Figure 5. Increase in Sales for Select Industries in Glenn-Driven Sectors in Northeast Ohio, FY 2009

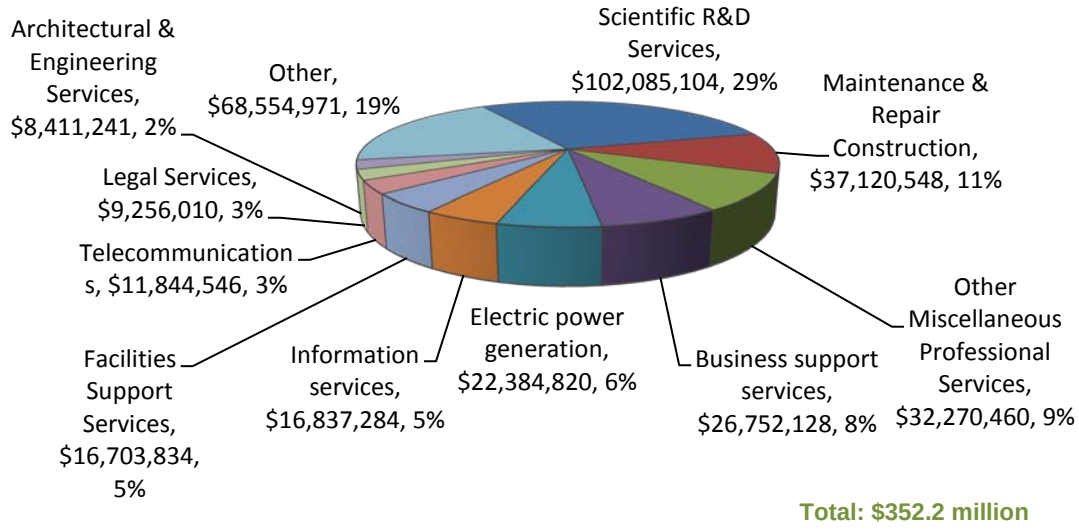
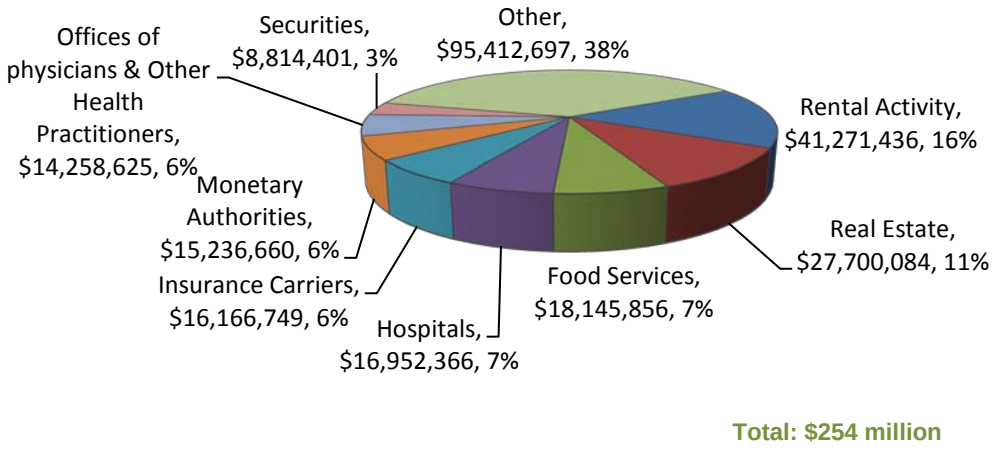


Figure 6. Increase in Sales for Select Industries in Consumer-Driven Sectors in Northeast Ohio, FY 2009



D.2.2 Employment Impact on Northeast Ohio in FY 2009

NASA Glenn's operation in Northeast Ohio affects job creation beyond Glenn's hiring of its own employees (change in final demand). Glenn spending triggers increased employment in industries from which it purchases goods and services (direct impact) and employment in industries that provide inputs into those goods. In addition, monies spent by employees of NASA Glenn employees and those companies with which Glenn does business create jobs in a variety of other industries (induced impact). Total employment impact equals the sum of Glenn Research Center full-time equivalent employment, direct impact, indirect impact, and induced impact. Table 8 shows the number of jobs created by the industry sectors.

Table 8. Employment Impact Based on Glenn Spending in Northeast Ohio, FY 2009

NASA Glenn Expenditures in Northeast Ohio: $441,751,294

Industry	Direct	Indirect	Induced	Total**
Agriculture, forestry, fishing & hunting	0	3	5	8
Mining	0	3	1	4
Utilities	40	3	9	51
Construction	348	23	20	392
Manufacturing	6	16	28	50
Wholesale Trade	0	17	93	110
Retail trade	19	24	582	626
Transportation & Warehousing	0	36	54	90
Information	42	30	41	113
Finance & insurance	0	41	184	225
Real estate & rental	1	62	151	215
Professional- scientific & tech services	872	172	119	1,163
Management of companies	0	13	14	27
Administrative & waste services	485	233	132	850
Educational services	50	1	109	160
Health & social services	10	0	529	540
Arts- entertainment & recreation	0	9	66	74
Accommodation & food services	0	57	297	354
Other services	0	36	237	274
Government & non NAICS	0	13	28	40
TOTAL	1,876	792	2,699	5,367
Change in final demand*	1,650			
Direct impact	1,876			
Indirect impact	792			
Induced impact	2,699			
Total employment impact	**7,017**			

**For employment impact, the change in final demand equals to the number of full-time equivalent employees working for NASA Glenn.*

***Total does not add up to "Direct + Indirect + Induced" because of rounding.*

The total employment impact by Glenn Research Center on the Northeast Ohio economy in FY 2009 was 7,017 jobs. Out of the total employment, 1,650 (23.5%) were directly employed at NASA Glenn. As a result of Glenn's direct spending for goods and services purchased in the region, 1,876 jobs (26.7%) were created. The remaining employment impact, 3,491 jobs (49.8%), is in the form of indirect and induced impacts as Glenn spending ripples through the economy.

Of the 5,367 jobs created in Northeast Ohio due to the direct, indirect, and induced impacts, 2,730 (50.9%) were found in the Glenn-driven sectors, 2,307 (43.0%) were in the consumer-driven sectors, and 330 (6.1%) fall under the category of other sectors.[20] The job distribution for select industries within the Glenn-driven sectors is shown in Figure 7. The job distribution for select industries within the consumer-driven sectors is shown in Figure 8. The industries presented in figures 7 and 8 are the leading industries with the most increased employment (65 in Figure 7 and 85 in Figure 8).

NASA Glenn's scientific R&D services generated the highest number of additional jobs. Companies engaged in scientific R&D (professional, scientific, and technical services sector) saw an increase of 764 jobs in FY 2009 due to NASA Glenn operation (Figure 6). These jobs are the summation of the direct, indirect, and induced employment impacts generated primarily but not exclusively by Glenn spending for R&D contractors in Northeast Ohio. The 764 jobs account for 28% of the 2,730 jobs that were created in all industries within the Glenn-driven sectors.

Food and beverage stores (retail trade sector) saw an increase of 109 jobs in FY 2009 because of Glenn spending (Figure 8). These jobs are the summation of the direct, indirect, and induced employment impacts generated primarily by Glenn employees and other workers for food and drink products. The 109 jobs account for 4.7% of the 2,307 jobs that were created in all industries within the consumer-driven sectors.

[20] Glenn-driven sectors include utilities, construction, information, professional and scientific services, administrative and support services, and education. Consumer-driven sectors include retail, finance and insurance, real estate, healthcare, entertainment and food, other services, and owner-occupied buildings.

Figure 7. Increase in Jobs for Select Industries in Glenn-Driven Sectors in Northeast Ohio, FY 2009

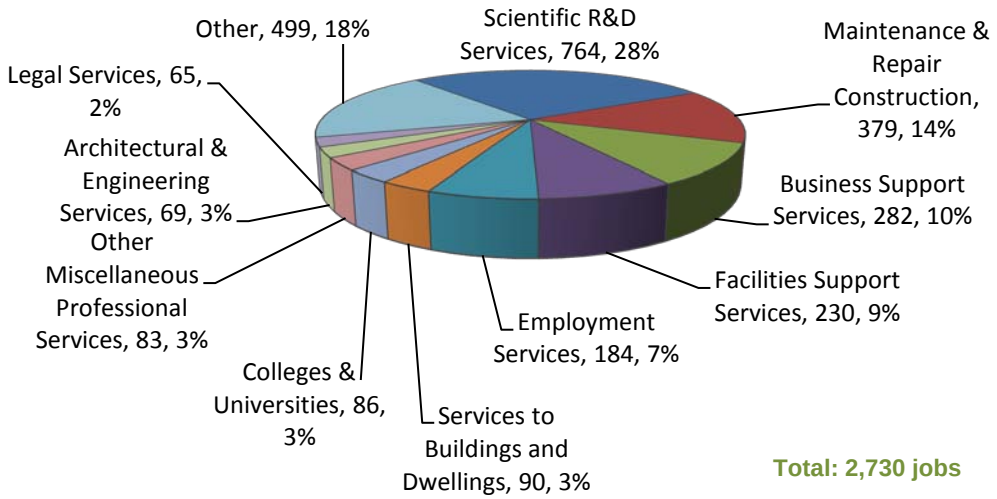
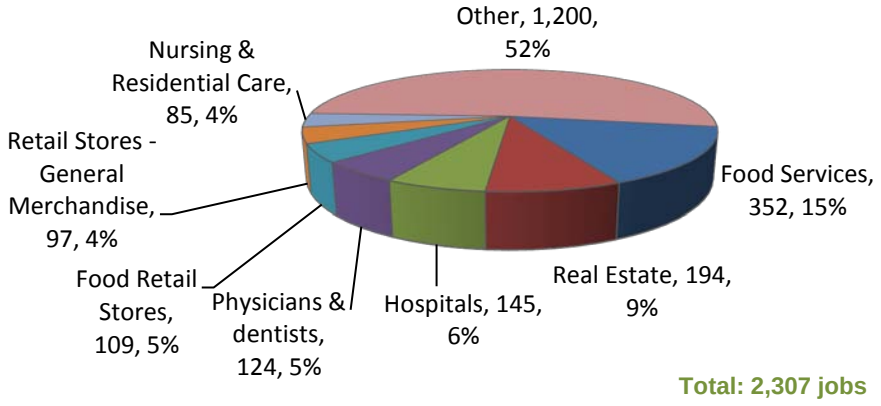


Figure 8. Increase in Jobs for Select Industries in Consumer-Driven Sectors in Northeast Ohio, FY 2009



D.2.3 Labor Income Impact on Northeast Ohio in FY 2009

Labor income impact[21] is the estimated total change in earnings paid to local households due to spending by Glenn Research Center for goods and services from businesses and other entities in Northeast Ohio. Monies paid to employees of companies and other entities who supply goods and services to Glenn represent direct earnings impact. Indirect impact is estimated by summing the monies paid to persons who work for companies that provide inputs to the producers of the goods and services ultimately consumed by Glenn.

Induced impact represents monies paid to workers in all industries who are employed as a result of purchases by households whose income is affected by the demand for products and services created by Glenn. Adding the direct, indirect, and induced impacts to the disposable income and healthcare benefits received by Glenn employees (final demand change) results in total earnings impact. Table 9 shows earnings impact by industry sector.

[21] In previous studies referred as household earnings impact.

Table 9. Labor Income* Impact Based on Glenn Spending in Northeast Ohio, FY 2009

NASA Glenn Expenditures in Northeast Ohio: $441,751,294

Industry	Direct	Indirect	Induced	Total***
Agriculture, forestry, fishing & hunting	$0	$45,040	$81,717	$126,757
Mining	$0	$253,034	$121,496	$374,529
Utilities	$4,512,254	$336,311	$1,051,222	$5,899,787
Construction	$18,124,814	$1,254,102	$918,067	$20,296,980
Manufacturing	$401,572	$1,109,527	$1,746,241	$3,257,340
Wholesale Trade	$2,151	$1,236,786	$6,808,850	$8,047,786
Retail trade	$387,009	$671,725	$15,780,304	$16,839,038
Transportation & Warehousing	$21,894	$1,812,576	$2,663,433	$4,497,904
Information	$1,745,375	$1,817,813	$2,348,607	$5,911,796
Finance & insurance	$0	$2,892,271	$12,470,160	$15,362,431
Real estate & rental	$95,436	$1,702,687	$3,777,216	$5,575,338
Professional- scientific & tech services	$66,956,115	$11,863,261	$7,578,206	$86,397,580
Management of companies	$0	$1,282,339	$1,440,171	$2,722,509
Administrative & waste services	$20,882,949	$7,122,939	$4,136,229	$32,142,117
Educational services	$1,794,768	$16,244	$2,823,160	$4,634,172
Health & social services	$478,693	$18,962	$24,379,110	$24,876,765
Arts- entertainment & recreation	$0	$217,656	$1,649,903	$1,867,559
Accommodation & food services	$0	$956,781	$4,959,317	$5,916,098
Other services	$8,126	$1,372,259	$5,831,810	$7,212,195
Government & non NAICS	$71	$949,244	$2,101,454	$3,050,768
TOTAL	$115,411,226	$36,931,553	$102,666,674	$255,009,451
Change in final demand**	$183,716,770			
Direct impact	$115,411,226			
Indirect impact	$36,931,553			
Induced impact	$102,666,674			
Total labor income impact	**$438,726,224**			

**Labor income constitutes economic impact through households of NASA employees and those affected by NASA operations throughout the economy. It is called in previous studies "Household earnings impact".*

***For labor income impact, change in final demand is equal to the disposable income (75% of gross income) plus healthcare benefits paid to Glenn employees.*

****Total does not add up to "Direct + Indirect + Induced" because of rounding.*

Total labor income in Northeast Ohio increased by $438.7 million as a result of Glenn's spending in FY 2009 for goods and services. Out of this total amount, $183.7 million (41.9%) is disposable income, plus healthcare benefits, paid directly to NASA Glenn employees, i.e., change in final demand. Out of total impact, $115.4 million (26.3%) represents monies paid to employees of companies in Northeast Ohio that supply goods and services to Glenn, i.e., direct impact. The remaining earnings impact, (indirect and induced components) estimated at $139.6 million (31.8%), occurs as the effects of Glenn spending ripples through the Northeast Ohio economy.

Of the $255 million increase in labor income generated across Northeast Ohio due to the direct, indirect, and induced impacts, $155.3 million (60.9%) was reported in Glenn-driven sectors; $77.7 (30.4%) was generated in consumer-driven sectors; and $22 million (8.7%) was reported in other sectors.[22] The labor income distribution for select industries within the Glenn-driven sectors is shown in Figure 9.

The labor income distribution for select industries within the consumer-driven sectors is shown in Figure 10. Selected industries, shown in Figures 9 and 10, added over $3 million each.

Persons engaged in legal services saw their household earnings increase by $4.6 million in FY 2009 (Figure 9). These earnings are the summation of the direct, indirect, and induced impacts generated primarily, but not exclusively, by Glenn spending for legal services. The $4.6 million is 3% of the $155.3 million labor income increase that was reported by all industries within the Glenn-driven sectors.

Persons working in food services and drinking places saw their household earnings increase by $5.9 million in FY 2009 (Figure 10). These earnings are the summation of the direct, indirect, and induced impacts generated by consumer spending at restaurants and bars. The $5.9 million accounts for a 7.6% of the $77.7 million labor income increase that occurred in all industries within the consumer-driven sectors.

[22] See section D.2.1 Output Impact on Northeast Ohio for definitions of Glenn-driven, consumer-driven, and other sectors.

Figure 9. Increase in Labor Income for Select Industries in Glenn-Driven Sectors in Northeast Ohio, FY 2009

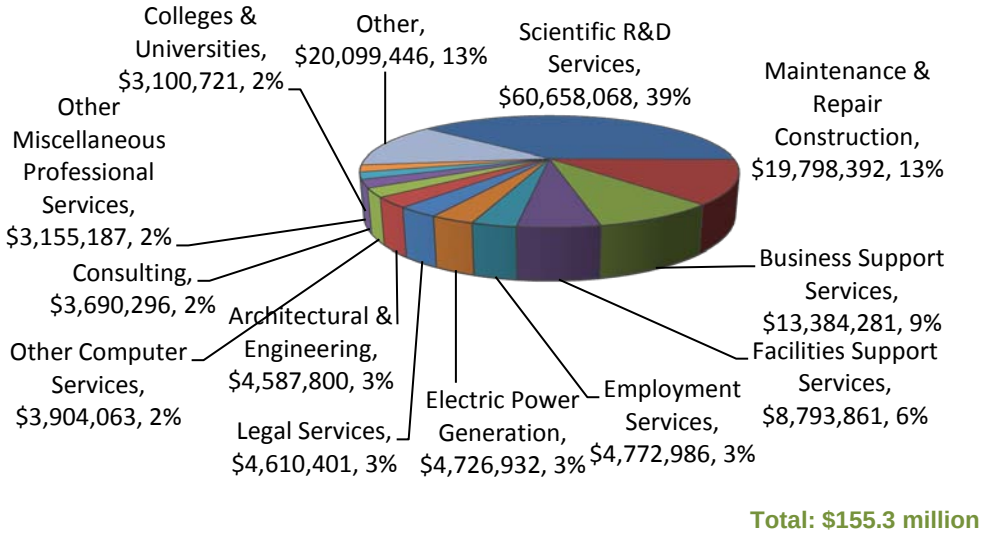
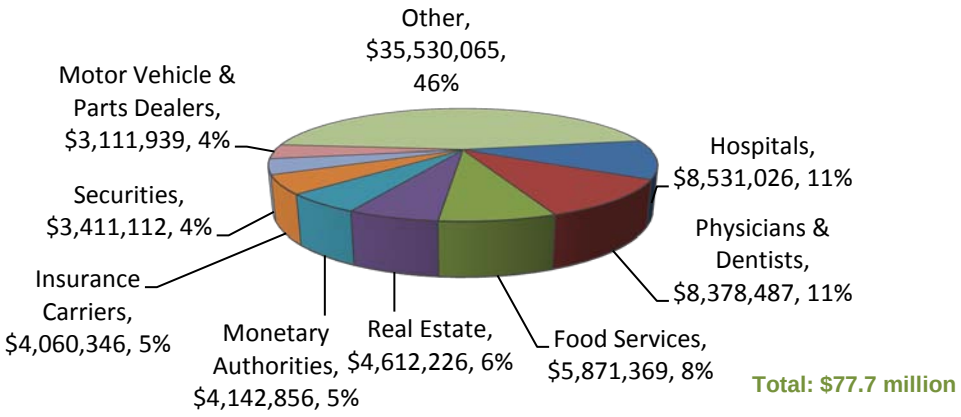


Figure 10. Increase in Labor Income for Industries in Consumer-Driven Sectors in Northeast Ohio, FY 2009



D.2.4 Value Added Impact on Northeast Ohio in FY 2009

Value added measures the economic impact of all goods and services produced in Northeast Ohio because of operation of NASA Glenn excluding intermediary goods which are goods used in the production of other goods and not for final consumption. Glenn spending affected a $384.5 million increase in sales (direct, indirect, and induced impacts) by all industries excluding intermediary goods and services. The disposable income and healthcare benefits received by Glenn employees constitute the final demand change for value added. Sales of companies and other entities who supply goods and services to Glenn excluding value of intermediary goods and services represent direct value- added impact.

Indirect impact is estimated by summing the sales of companies that provide inputs to the producers of the goods and services ultimately consumed by Glenn excluding value of intermediary goods and services. Induced impact represents sales excluding intermediary goods and services in all industries that produce products for households whose income is affected by the demand for products and services created by Glenn. Adding the direct, indirect, and induced impacts to the disposable income and healthcare benefits received by Glenn employees (final demand change) results in total value- added impact. Table 10 shows earnings impact by industry sector.

Table 10. Value-Added Impact Based on Glenn Spending in Northeast Ohio, FY 2009

NASA Glenn Expenditures in Northeast Ohio: $441,751,294

Industry	Direct	Indirect	Induced	Total**
Agriculture, forestry, fishing & hunting	$0	$61,958	$170,452	$232,410
Mining	$0	$612,521	$316,397	$928,918
Utilities	$14,654,800	$1,118,472	$3,492,251	$19,265,523
Construction	$19,027,076	$1,321,461	$1,181,768	$21,530,303
Manufacturing	$560,845	$1,674,253	$2,748,153	$4,983,250
Wholesale Trade	$3,694	$2,124,060	$11,693,540	$13,821,293
Retail trade	$559,671	$1,096,521	$25,867,601	$27,523,793
Transportation & Warehousing	$29,197	$2,740,296	$3,716,151	$6,485,643
Information	$4,795,554	$4,025,512	$5,045,344	$13,866,410
Finance & insurance	$0	$5,618,815	$21,064,419	$26,683,236
Real estate & rental	$175,882	$7,285,766	$44,554,419	$52,016,070
Professional- scientific & tech services	$71,359,214	$14,639,772	$9,292,155	$95,291,137
Management of companies	$0	$1,721,841	$1,933,769	$3,655,610
Administrative & waste services	$25,875,175	$8,740,269	$5,259,171	$39,874,615
Educational services	$1,920,378	$19,300	$3,083,461	$5,023,139
Health & social services	$842,755	$32,250	$28,457,749	$29,332,755
Arts- entertainment & recreation	$0	$275,670	$2,350,902	$2,626,572
Accommodation & food services	$0	$1,436,633	$7,435,917	$8,872,550
Other services	$14,703	$1,999,972	$7,188,723	$9,203,398
Government & non NAICS	$92	$960,391	$2,323,552	$3,284,035
TOTAL	$139,819,036	$57,505,731	$187,175,893	$384,500,659
Change in final demand*	$183,716,770			
Direct impact	$139,819,036			
Indirect impact	$57,505,731			
Induced impact	$187,175,893			
Total value- added impact	**$568,217,430**			

**For value-added impact, change in final demand is equal to the disposable income (75% of gross income) plus healthcare benefits paid to Glenn employees.*
***Total does not add up to "Direct + Indirect + Induced" because of rounding.*

Total value added in Northeast Ohio increased by $568.2 million in FY 2009 as a result of Glenn's spending for goods and services. Out of this total amount, $183.7 million (32.3%) is disposable income, plus healthcare benefits, paid directly to NASA Glenn employees--change in final demand. Out of total impact, $139.8 million (24.6%) represents values of goods and services less intermediary goods of companies in Northeast Ohio that supply goods and services to Glenn, i.e., direct impact. The remaining value-added impact, (indirect and induced components) estimated at $244.7 million (43.1%), occurs as the effects of Glenn spending ripples through the Northeast Ohio economy.

Of the $384.5 million increase in value added generated across Northeast Ohio due to the direct, indirect, and induced impacts, $194.9 million (50.7%) was reported in Glenn-driven sectors; $156.3 (40.6%) was generated in consumer-driven sectors; and $33.4 million (8.7%) was reported in other sectors.[23] The value-added distribution for select industries within the Glenn-driven sectors is shown in Figure 11. The value-added distribution for select industries within the consumer-driven sectors is shown in Figure 12. Selected industries in Figures 11 and 12 added over $5.1 and $3.8 million, respectively.

Persons engaged in business support services saw their sector's value added increase by $18 million in FY 2009 (Figure 11). This increase of value added is a result of the summation of the direct, indirect, and induced impacts generated primarily, but not exclusively, by Glenn spending for business support services. The $18 million accounts for a 9.2% of the $194.9 million value-added increase that was reported by all industries within the Glenn-driven sectors.

Persons working in private hospitals saw their household earnings increase by $9 million in FY 2009 (Figure 12). These earnings are the summation of the direct, indirect, and induced impacts generated by consumer spending at restaurants and bars. The $9 million accounts for a 5.7% of the $156.3 million value added increase that occurred in all industries within the consumer-driven sectors.

[23] See section D.2.1 Output Impact on Northeast Ohio for definitions of Glenn-driven, consumer-driven, and other sectors.

Figure 11. Increase in Value Added for Select Industries in Glenn-Driven Sectors in Northeast Ohio, FY 2009

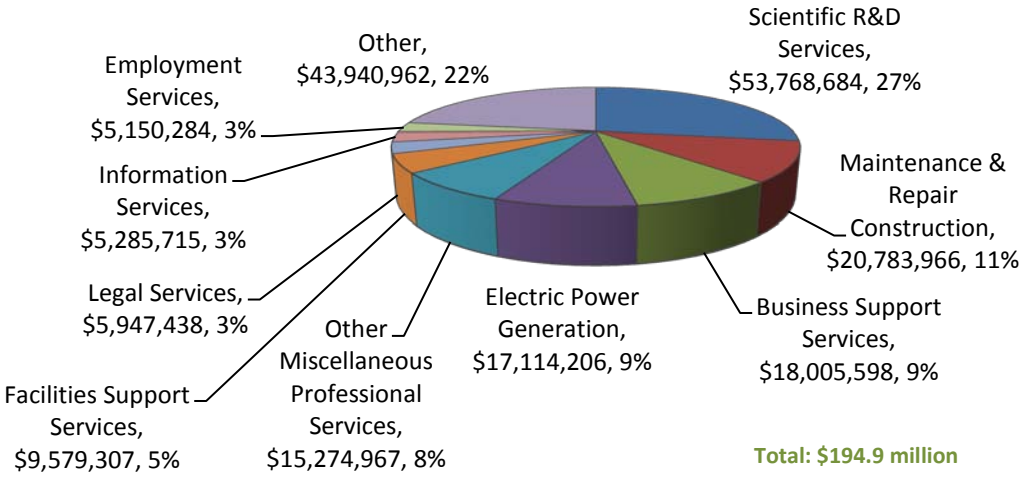
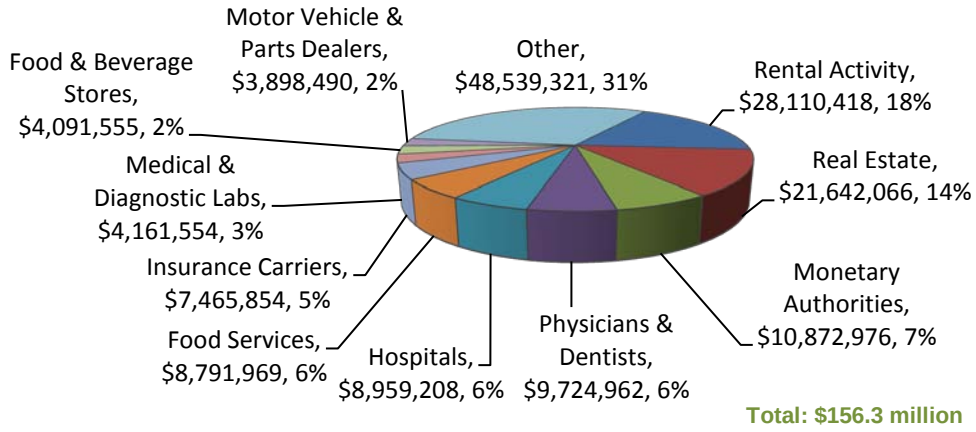


Figure 12. Increase in Value Added for Industries in Consumer-Driven Sectors in Northeast Ohio, FY 2009



D.2.5 Tax Impact on Northeast Ohio in FY 2009

The NASA Glenn operation in FY 2009 increased tax revenues by a total of $87.5 million. Of that, state and local governments in Northeast Ohio benefited from increased tax revenues of $37.9 million. Federal tax revenues in FY 2009 increased by $49.6 million.

D.2.6 FY 2009 Northeast Ohio Impact Summary

Economic activity generated by Glenn Research Center produced the following impact on Northeast Ohio (2009 dollars):

- Total Output Impact: $1,213.2 M
- Total Employment Impact: 7,017 jobs
- Total Labor Income Impact: $344.4 M
- Total Value-Added Impact: $568.2 M
- Total Tax Impact: $87.5 M

The economic impact presented here reflects benefits of NASA Glenn expenditures in Northeast Ohio in FY 2009. During that time period, 43.2% ($371.4 million) of Glenn expenditures were allocated to Glenn payroll; scientific research and development services; maintenance and repair construction of nonresidential structures; other miscellaneous professional, scientific, and technical services; and business support services.

Other industries deriving significant benefits from direct Glenn spending include electric power generation, transmission, and distribution; facilities support services; and other information services. Businesses deriving the most benefit from spending by Glenn personnel and other workers whose earnings are due in part to Glenn expenditures follow typical consumer spending patterns. These include food services, real estate companies, hospitals and healthcare services, motor vehicle dealers, accounting services, commercial banks, and miscellaneous retailers.

D.3 Economic Impact on the State of Ohio in FY 2009

In this section, we present the economic impact that NASA Glenn had on the Ohio economy during FY 2009 spending. The economic impact is discussed through a detailed analysis of the change in output (sales), employment, and labor income (household earning), value added and taxes due to Glenn activities. This section follows the structure of Section D.2, Economic Impact on Northeast Ohio.

D.3.1 Output Impact on the State of Ohio in FY 2009

The economic impact analysis uses multipliers to estimate the ripple effect that an initial expenditure has on a studied economy. These multipliers measure the effect of NASA Glenn Research Center spending on output (sales) across the state of Ohio. The multipliers that are applied to spending in Ohio are generally larger than those applied to expenditures in Northeast Ohio because a larger geographic area assures less leakage from the economy. Stated another way, as the geographic area being analyzed increases in size, the amount of goods and services purchased from outside that area decreases.

NASA Glenn expenditures were divided into spending on goods and services purchased from companies and other entities located in the state of Ohio (local) and spending for goods and services from businesses located elsewhere. Local spending is then categorized by industry, based upon the IMPLAN industry classification system. Table A.4 in Appendix A lists detailed Glenn expenditures by specific industry.

Table 11 presents the total output impact and its components. Local Glenn expenditures represent direct output impact. Indirect impact is estimated by summing the contributions of individual industries that provide inputs to the producers of the goods and services ultimately consumed by NASA Glenn. Induced impact is estimated by measuring the spending of workers who are employed as a result of the demand for products and services created by Glenn. Total output impact is the sum of change in final demand, direct impact, indirect impact, and induced impact. Table 11 reports output impacts by industry sector, illustrating how Glenn spending across Ohio affects all sectors of the economy.[24]

[24] Disposable income spent by Glenn employees is automatically distributed by IMPLAN to those industries from which households typically make purchases. As a result, "households" is not identified as a unique industry sector in Table 11.

Table 11. Output Impact Based on Glenn Spending in the State of Ohio, FY 2009

NASA Glenn Expenditures in Ohio: $510,161,454

Industry	Direct	Indirect	Induced	Total**
Agriculture, Forestry, Fishing & Hunting	$0	$301,482	$1,153,949	$1,455,432
Mining	$0	$805,838	$446,815	$1,252,653
Utilities	$19,485,702	$2,644,313	$6,929,847	$29,059,863
Construction	$35,578,128	$3,307,827	$2,528,897	$41,414,851
Manufacturing	$2,971,199	$8,853,729	$22,657,401	$34,482,329
Wholesale Trade	$81,996	$3,716,026	$18,511,554	$22,309,576
Retail trade	$941,729	$1,925,930	$45,185,857	$48,053,517
Transportation & Warehousing	$92,694	$6,123,630	$8,601,194	$14,817,518
Information	$15,305,543	$16,459,249	$16,630,676	$48,395,468
Finance & insurance	$0	$11,196,132	$44,329,035	$55,525,167
Real estate & rental	$422,691	$10,539,633	$66,630,689	$77,593,013
Professional- scientific & tech services	$190,830,597	$28,117,270	$15,132,660	$234,080,532
Management of companies	$0	$3,440,394	$3,766,494	$7,206,888
Administrative & waste services	$46,632,603	$16,866,865	$9,386,309	$72,885,778
Educational services	$8,109,272	$54,099	$5,355,144	$13,518,514
Health & social services	$1,320,614	$54,929	$54,096,997	$55,472,541
Arts- entertainment & recreation	$0	$629,004	$6,190,603	$6,819,607
Accommodation & food services	$0	$3,993,983	$18,517,493	$22,511,477
Other services	$28,040	$4,196,528	$15,611,150	$19,835,718
Government & non NAICs	$54,323	$2,271,098	$5,495,283	$7,820,703
TOTAL	$321,855,130	$125,497,960	$367,158,047	$814,511,142
Change in final demand	$541,159,506			
Direct impact	$321,855,130			
Indirect impact	$125,497,960			
Induced impact	$367,158,047			
Total output impact	**$1,355,670,643**			

**For output impact, the change in final demand equals spending by Glenn within and outside Ohio excluding payroll and health benefits.*
***Total does not add up to "Direct + Indirect + Induced" because of rounding.*

The total output impact across the state of Ohio as a result of Glenn Research Center activities in FY 2009 was over $1.35 billion. Glenn's expenditures of $510.2 million resulted in an increase in output (sales) of $814.5 million across all industry sectors (Table 11). For example, Glenn spending affected a $34.5 million increase in sales (direct, indirect, and induced impacts) by the manufacturing sector and $234.1 million in professional, scientific, and technical services.

Of the total output impact, 40% ($541.2 million) is accounted for by the change in final demand that occurs because Glenn activities bring resources into Ohio from outside the state. Approximately $321.9 million (23.7%) of the total output impact is a result of direct spending by Glenn for goods and services purchased within the state of Ohio. The remaining output impact of $492.7 million (36.3%) is attributable to the indirect and induced components as Glenn spending ripples through the economy.

An analysis of the IMPLAN model shows that the $814.5 million increase in sales generated by the direct, indirect, and induced impacts can be divided into the same broad categories that were identified for Northeast Ohio—Glenn-driven sectors ($439.4 million, 53.9%), consumer-driven sectors ($285.8 million, 35.1%), and other sectors ($89.3 million, 11%).[25]

The output distribution for select industries within the Glenn-driven sectors is shown in Figure 13. The output distribution for select industries within the consumer-driven sectors is shown in Figure 14. Selected industries in these figures added over $12 million and $6 million, respectively.

Colleges and universities (education sector) across the state of Ohio saw an increase in revenues of $10.6 million in FY 2009 (Figure 13). This amount is the summation of the direct, indirect, and induced impacts generated primarily but not exclusively by Glenn spending for research by colleges and universities. This increase of $10.6 million accounts for a 2% share of the $439.4 million increase in output value for all industries within the Glenn-driven sectors.

Insurance carriers (finance and insurance sector) experienced a sales increase of $18.4 million in FY 2009 (Figure 14). This amount is the summation of the direct, indirect, and induced impact components generated primarily by Glenn employees and other workers for insurance products. This increase of $18.4 million represents a 6% share of the $285.8 million increase in output for all industries within the consumer-driven sectors.

[25] Glenn-driven sectors include utilities, construction, information, professional and scientific services, administrative and support services, and education. Consumer-driven sectors include retail, finance and insurance, real estate, health care, entertainment and food, other services, and owner-occupied buildings.

Figure 13. Increase in Sales for Select Industries in Glenn-Driven Sectors, Ohio, FY 2009

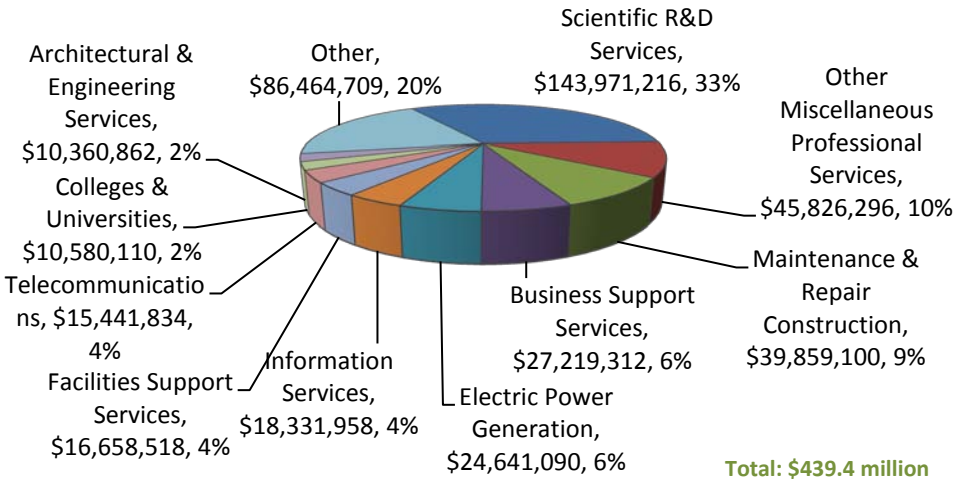
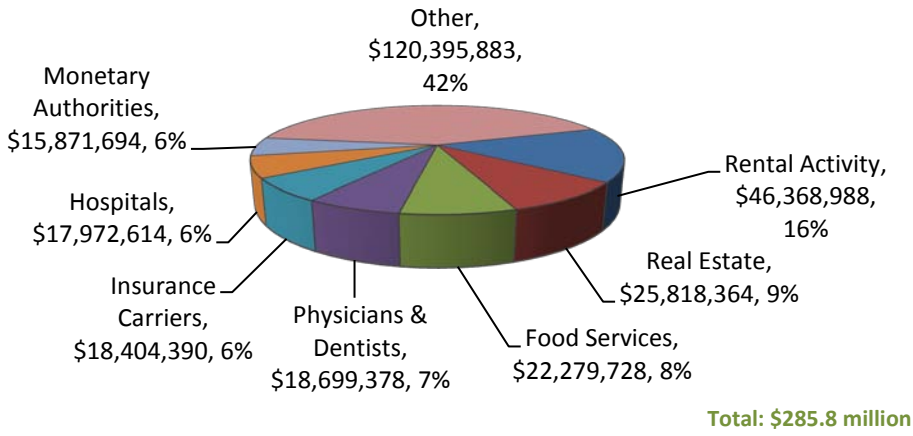


Figure 14. Increase in Sales for Select Industries in Consumer-Driven Sectors, Ohio, FY 2009



D.3.2 Employment Impact on the State of Ohio in FY 2009

Glenn Research Center's activities affect job creation beyond Glenn's hiring of its own employees (change in final demand). Glenn spending creates employment across the state of Ohio in industries from which it purchases goods and services (direct impact) and employment in industries that provide inputs into those goods and services (indirect impact). In addition, monies spent by Glenn employees and employees of those companies with which NASA Glenn does business create jobs in a variety of other industries (induced impact). Total employment impact equals the sum of Glenn Research Center full-time equivalent employment and the direct, indirect, and induced components. Table 12 shows the number of jobs created by industry sector.

Table 12. Employment Impact Based on Glenn Spending in the State of Ohio, FY 2009

NASA Glenn Expenditures in Ohio: $510,161,454

Industry	Direct	Indirect	Induced	Total**
Agriculture, Forestry, Fishing & Hunting	0	4	12	16
Mining	0	2	1	4
Utilities	41	4	11	56
Construction	376	32	27	435
Manufacturing	10	25	48	83
Wholesale Trade	0	20	101	122
Retail trade	24	30	701	755
Transportation & Warehousing	1	46	69	116
Information	33	42	50	125
Finance & insurance	0	54	207	261
Real estate & rental	1	65	143	209
Professional- scientific & tech services	1,192	192	121	1,505
Management of companies	0	15	16	30
Administrative & waste services	683	309	155	1,147
Educational services	121	1	106	228
Health & social services	10	0	623	634
Arts- entertainment & recreation	0	13	85	98
Accommodation & food services	0	77	360	438
Other services	0	49	285	335
Government & non NAICs	0	16	31	48
TOTAL	2,493	998	3,152	6,643
Change in final demand*	1,650			
Direct impact	2,493			
Indirect impact	998			
Induced impact	3,152			
Total employment impact	**8,293**			

**For employment impact, the change in final demand equals to the number of full-time equivalent employees working for NASA Glenn.*

***Total does not add up to "Direct + Indirect + Induced" because of rounding.*

Employment increased by 8,239 jobs across the state of Ohio in FY 2009 because of the presence of NASA Glenn. Of these jobs, 1,650 people (20%) are directly employed at Glenn. As a result of Glenn's direct spending for goods and services purchased in Ohio, 2,493 jobs (30%) were created. The remaining employment impact—4,151 jobs (50%)—is in the form of indirect and induced impacts as NASA Glenn spending ripples through the economy.

Of the 6,643 jobs created in Ohio due to the direct, indirect, and induced components, 3,496 (52.6%) are found in the Glenn-driven sectors, 2,729 (41.1%) are in the consumer-driven sectors, and 418 (6.3%) fall under other sectors.[26] The job distribution for select industries within the Glenn-driven sectors is shown in Figure 15. The job distribution for select industries within the consumer-driven sectors is shown in Figure 16. Selected industries in these figures added the most jobs (over 100 in Figure 15 and Figure 16).

Because of Glenn Research Center spending in the state of Ohio, 1,052 jobs were added in scientific R&D services during FY 2009 (Figure 15). These jobs are the summation of the direct, indirect, and induced employment impacts generated primarily but not exclusively by Glenn's need for information services. The 1,052 jobs account for a 30% share of the 3,496 jobs that were created in all industries within the Glenn-driven sectors.

The food services industry experienced an increase of 435 jobs in FY 2009 (Figure 16). These jobs are the summation of the direct, indirect, and induced components generated primarily by NASA Glenn employees and other workers who patronize restaurants and bars. The 435 jobs account for a 16% share of the 2,729 jobs that were created in all industries within the consumer-driven sectors.

[26] Glenn-driven sectors include utilities, construction, information, professional and scientific services, administrative and support services, and education. Consumer-driven sectors include retail, finance and insurance, real estate, healthcare, entertainment and food, other services, and owner-occupied buildings.

Figure 15. Increase in Jobs for Select Industries in Glenn-Driven Sectors in Ohio, FY 2009

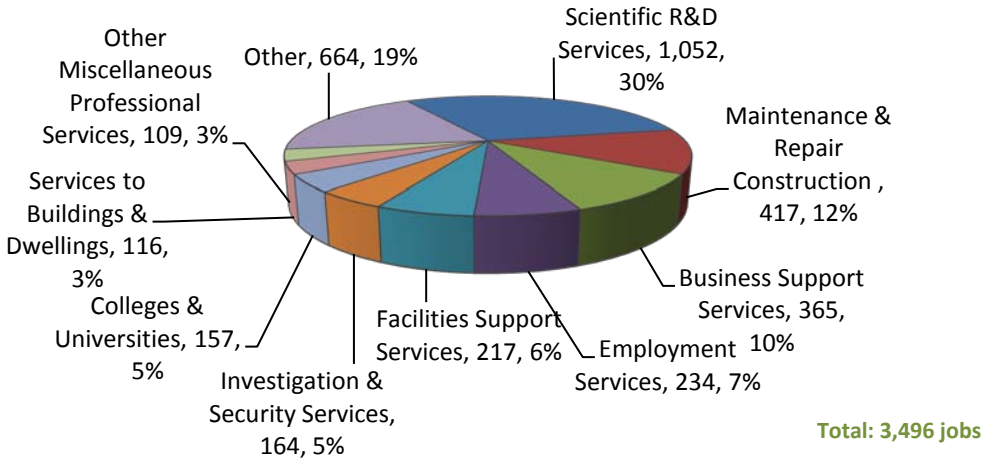
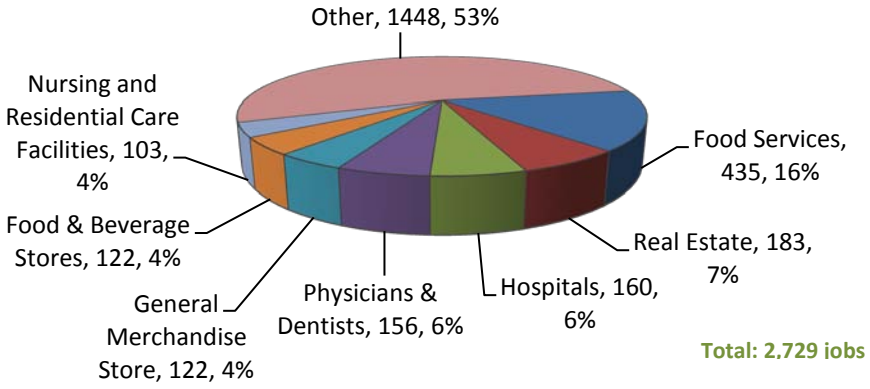


Figure 16. Increase in Jobs for Select Industries in Consumer-Driven Sectors in Ohio, FY 2009



D.3.3 Labor Income Impact on the State of Ohio in FY 2009

Labor income (household earnings) is the estimated change in earnings received by households in the state of Ohio due to spending by Glenn Research Center for goods and services from businesses and other entities across the state. Monies paid to employees of companies and other entities who supply goods and services to Glenn represent direct earnings impact. Indirect impact is estimated by summing the monies paid to persons who work for companies that provide inputs to the producers of the goods and services ultimately consumed by Glenn. Induced impact represents monies paid to workers in all industries who are employed as a result of the demand for products and services created by NASA Glenn. Adding the direct, indirect, and induced impacts to the disposable income and healthcare benefits received by Glenn employees (final demand change) results in total earnings impact. Table 13 shows labor income impact by industry sector.

Table 13. Labor Income Impact Based on Glenn Spending in the State of Ohio, FY 2009

NASA Glenn Expenditures in Ohio: $510,161,454

Industry	Direct	Indirect	Induced	Total***
Agriculture, Forestry, Fishing & Hunting	$0	$63,615	$176,955	$240,570
Mining	$0	$208,292	$104,089	$312,381
Utilities	$4,533,415	$499,162	$1,351,245	$6,383,823
Construction	$18,682,968	$1,661,408	$1,164,329	$21,508,706
Manufacturing	$674,979	$1,582,527	$3,027,916	$5,285,421
Wholesale Trade	$30,953	$1,393,843	$6,943,491	$8,368,286
Retail trade	$485,428	$796,687	$18,514,905	$19,797,018
Transportation & Warehousing	$27,959	$2,325,542	$3,503,664	$5,857,165
Information	$2,396,444	$2,711,304	$2,906,526	$8,014,274
Finance & insurance	$0	$3,384,419	$13,143,506	$16,527,924
Real estate & rental	$94,305	$1,809,712	$3,621,315	$5,525,332
Professional- scientific & tech services	$95,051,912	$13,002,596	$7,282,067	$115,336,563
Management of companies	$0	$1,593,783	$1,744,851	$3,338,633
Administrative & waste services	$24,282,897	$8,979,034	$4,659,429	$37,921,360
Educational services	$3,958,495	$21,986	$2,756,026	$6,736,508
Health & social services	$478,308	$19,705	$28,549,081	$29,047,094
Arts- entertainment & recreation	$0	$242,114	$1,819,104	$2,061,218
Accommodation & food services	$0	$1,288,388	$5,971,432	$7,259,820
Other services	$10,359	$1,614,610	$6,502,172	$8,127,141
Government & non NAICs	$36,423	$1,152,601	$2,229,704	$3,418,727
TOTAL	$150,744,844	$44,351,329	$115,971,806	$311,067,965
Change in final demand**	$183,716,770			
Direct impact	$150,744,844			
Indirect impact	$44,351,329			
Induced impact	$115,971,806			
Total labor income impact	**$494,784,749**			

**Labor income constitutes economic impact through households of NASA employees and those affected by NASA operations throughout the economy. It is called in previous studies "Earnings impact".*

***For labor income impact, change in final demand is equal to the disposable income (75% of gross income) plus healthcare benefits paid to Glenn employees.*

****Total does not add up to "Direct + Indirect + Induced" because of rounding.*

Total labor income in the state of Ohio increased by $494.8 million as a result of Glenn's spending for goods and services in FY 2009. Of this amount, $183.7 million (37.1%) is the disposable income and healthcare benefits paid to NASA Glenn employees (change in final demand). Monies paid to employees of companies across the state that supply goods and services to Glenn (direct impact) represent $150.7million (30.5%). The remaining earnings impact (indirect and induced components), estimated at $160.3 million (32.4%), occur as the effects of Glenn spending ripples through the Ohio economy.

Of the $311.1 million increase in household earnings attributed to the direct, indirect, and induced components, $195.9 million (63%) was reported in Glenn-driven sectors, $88.3 million (28.4%) occurred in consumer-driven sectors, and $26.9 million (8.6%) was reported in other sectors.[27] The household earnings distribution for select industries within the Glenn-driven sectors is shown in Figure 17. The household earnings distribution for select industries within the consumer-driven sectors is shown in Figure 18. Selected industries in these figures experienced the most gains in earnings (over $3.5 million each in Figure 17 and over $2.8 million each in Figure 18).

Employees in facilities that support services industries (administrative and support services sector) across the state of Ohio saw their household earnings increase by $9 million in FY 2009 (Figure 17). These earnings are the summation of the direct, indirect, and induced impacts generated primarily but not exclusively by NASA Glenn for facilities support services. The $9 million represents a 4% share of the $195.9 million earnings increase that occurred in all industries within the Glenn-driven sectors.

Persons working for motor vehicle and parts dealers (retail trade sector) experienced an increase in household earnings of $3.5 million in FY 2009 (Figure 18). This amount is the summation of the direct, indirect, and induced impacts generated primarily by Glenn employees and other workers on spending for automobiles and other types of motor vehicles. The $3.5 million accounts for a 4% share of the $88.3 million earnings increase that was reported by all industries within the consumer-driven sectors.

[27] See section D.2.1 Output Impact on Northeast Ohio for detailed definitions of Glenn-driven, consumer-driven, and other sectors.

Figure 17. Increase in Earnings for Select Industries in Glenn-Driven Sectors in Ohio, FY 2009

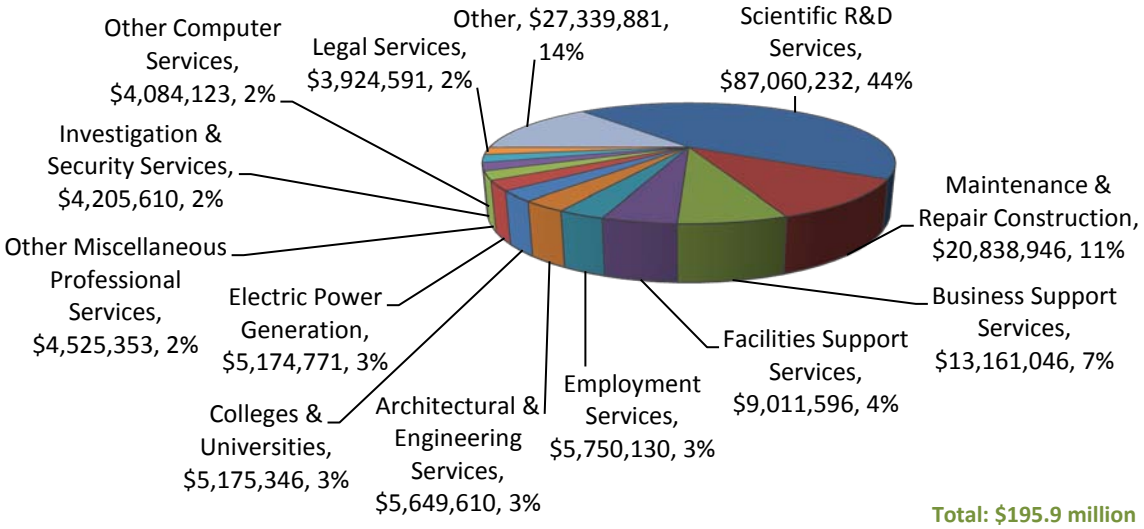
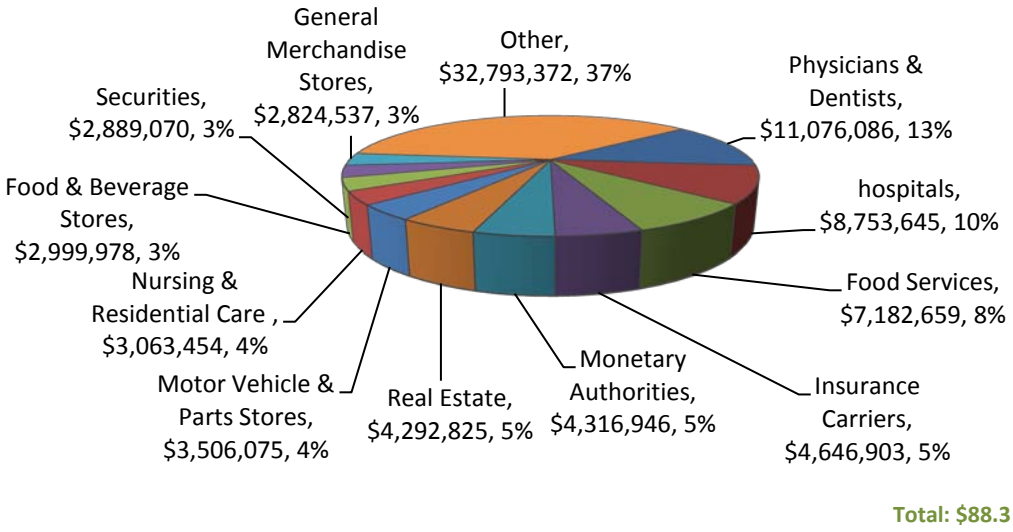


Figure 18. Increase in Earnings for Select Industries in Consumer-Driven Sectors in Ohio, FY 2009



D.3.4 Value-Added Impact on the State of Ohio in FY 2009

Value added measures economic impact of all goods and services produced in the state of Ohio due to NASA Glenn operation excluding intermediary goods. Glenn spending affected an increase in value added (direct, indirect, and induced impacts) by all industries (sales excluding intermediary goods and services). The disposable income and healthcare benefits received by Glenn employees constitute the final demand change for value added. Sales less intermediary goods and services of companies and other entities who supply goods and services to Glenn represent direct value-added impact. Indirect impact is estimated by summing the sales of companies that provide inputs to the producers of the goods and services ultimately consumed by Glenn excluding value of intermediary goods and services. Induced impact represents sales excluding intermediary goods and services in all industries that produce products for households whose income is affected by the demand for products and services created by Glenn. Adding the direct, indirect, and induced impacts to the disposable income and healthcare benefits received by Glenn employees (final demand change) results in total value-added impact. Table 14 shows earnings impact by industry sector.

Table 14. Value-Added Impact Based on Glenn Spending in the State of Ohio, FY 2009

NASA Glenn Expenditures in Ohio: $510,161,454

Industry	Direct	Indirect	Induced	Total**
Agriculture, Forestry, Fishing & Hunting	$0	$120,881	$469,343	$590,224
Mining	$0	$461,040	$262,167	$723,207
Utilities	$14,714,516	$1,692,898	$4,624,905	$21,032,321
Construction	$19,623,902	$1,751,169	$1,505,438	$22,880,508
Manufacturing	$978,343	$2,352,303	$5,001,672	$8,332,318
Wholesale Trade	$53,216	$2,396,395	$11,937,748	$14,387,358
Retail trade	$701,102	$1,310,688	$30,488,176	$32,499,966
Transportation & Warehousing	$39,883	$3,433,989	$4,906,861	$8,380,732
Information	$6,305,189	$6,146,633	$6,275,175	$18,726,996
Finance & insurance	$0	$6,589,191	$22,637,041	$29,226,231
Real estate & rental	$175,077	$7,539,138	$46,779,534	$54,493,746
Professional- scientific & tech services	$100,929,614	$16,579,859	$9,012,089	$126,521,549
Management of companies	$0	$2,137,105	$2,339,672	$4,476,777
Administrative & waste services	$29,706,448	$11,035,233	$5,943,132	$46,684,814
Educational services	$4,235,514	$26,377	$3,001,456	$7,263,346
Health & social services	$842,212	$33,671	$33,395,353	$34,271,236
Arts- entertainment & recreation	$0	$306,322	$2,664,634	$2,970,956
Accommodation & food services	$0	$1,936,769	$8,959,248	$10,896,017
Other services	$15,987	$2,313,343	$8,107,677	$10,437,008
Government & non NAICs	$38,676	$1,161,107	$2,434,817	$3,634,601
TOTAL	$178,359,679	$69,324,109	$210,746,135	$458,429,910
Change in final demand*	$183,716,770			
Direct impact	$178,359,679			
Indirect impact	$69,324,109			
Induced impact	$210,746,135			
Total value added impact	**$642,146,694**			

**For value added impact, change in final demand is equal to the disposable income (75% of gross income) plus healthcare benefits paid to Glenn employees.*
***Total does not add up to "Direct + Indirect + Induced" because of rounding.*

Total value added in the State of Ohio increased by $642.1 million as a result of Glenn's spending for goods and services in FY 2009. Out of this total amount, $183.7 million (28.6%) is disposable income, plus healthcare benefits, paid directly to NASA Glenn employees (change in final demand). Out of total impact, $178.4 million (27.8%) represents values of goods and services less intermediary goods of companies in Northeast Ohio that supply goods and services to Glenn (direct impact). The remaining value-added impact, (indirect and induced components) estimated at $280 million (43.6%), occurs as the effects of Glenn spending ripples through the Ohio economy.

Of the $458.4 million increase in value added generated across Northeast Ohio due to the direct, indirect, and induced impacts, $243.1 million (53%) was reported in Glenn-driven sectors; $174.8 (38.1%) was generated in consumer-driven sectors; and $40.5 million (8.9%) was reported in other sectors.[28] The value-added distribution for select industries within the Glenn-driven sectors is shown in Figure 19. The value-added distribution for select industries within the consumer-driven sectors is shown in Figure 20. Selected industries in Figures 19 and 20 added over $5 and $4.2 million, respectively.

Persons engaged in electric power generation saw the sector's value added increase by $18.8 million in FY 2009 (Figure 19). This increase is a result of the summation of the direct, indirect, and induced impacts generated primarily, but not exclusively, by Glenn spending for electric power generation. The $18.8 million accounts for 8% of the $243.1 million value-added increase that was reported by all industries within the Glenn-driven sectors.

Persons working in rental activity services saw their household earnings increase by $31.6 million in FY 2009 (Figure 20). These earnings are the summation of the direct, indirect, and induced impacts generated by consumer spending for renting. The $31.6 million accounts for 18% of the $174.8 million value-added increase that occurred in all industries within the consumer-driven sectors.

[28] See section D.2.1 Output Impact on Northeast Ohio for definitions of Glenn-driven, consumer-driven, and other sectors.

Figure 19. Increase in Value Added for Select Industries in Glenn-Driven Sectors in the State of Ohio, FY 2009

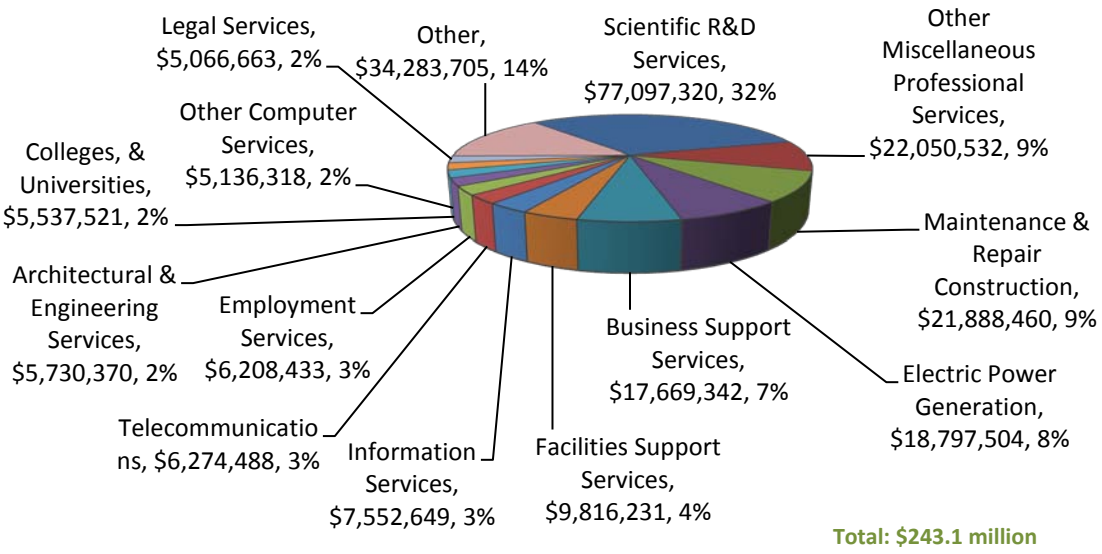
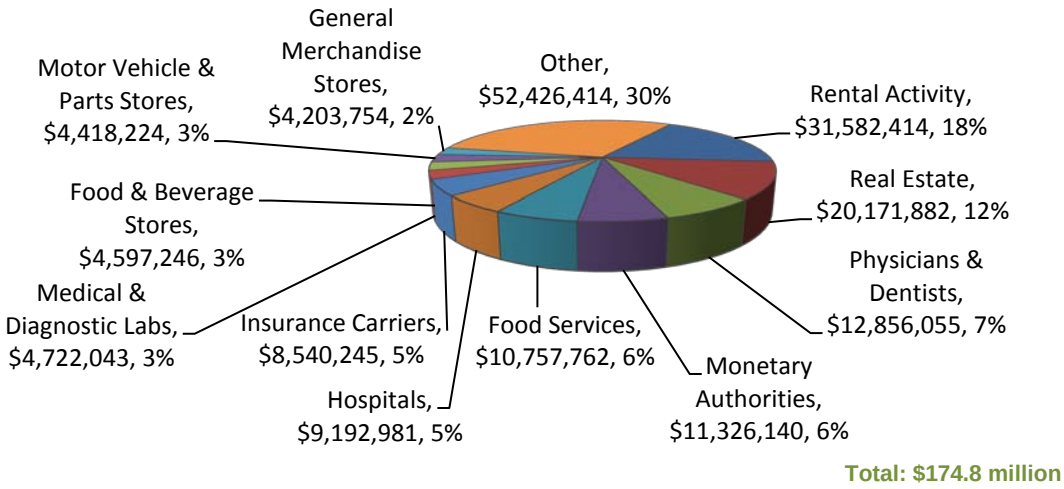


Figure 20. Increase in Value Added for Industries in Consumer-Driven Sectors in Northeast Ohio, FY 2009



D.3.5 Tax Impact on the State of Ohio in FY 2009

The operation of NASA Glenn in FY 2009 increased tax revenues by a total of $102.2 million as a result of Glenn's economic impact on the state of Ohio. Of that total, state and local governments in Ohio benefited from increased tax revenues of $43.6 million, and federal tax revenues increased by $58.6 million in FY 2009.

D.3.6 FY 2009 Ohio Impact Summary

Economic activity generated by the NASA Glenn Research Center produced the following impact on the state of Ohio (2009 dollars):

- Total Output Impact: $1,355.7 M
- Total Employment Impact: 8,293 jobs
- Total Labor Income Impact: $494.8 M
- Total Value-Added Impact: $642.1 M
- Total Tax Impact: $102.2 M

The impact of NASA Glenn's expenditures in the state of Ohio is only slightly higher than the impact on Northeast Ohio because the majority of Glenn's Ohio expenditures are in Northeast Ohio (including all of Glenn's payroll expenditures). In FY 2009, NASA Glenn's expenditures in the state of Ohio, excluding the eight-county Northeast Ohio region, were only $68.4 million. Almost 80% of this additional spending went to Ohio professional, scientific and technical services, including scientific R&D ($41.5 million); all other miscellaneous professional, scientific, and technical services ($11.2 million); and architectural, engineering and related services ($1.4 million). The result is that Ohio businesses, excluding those located in the eight-county Northeast Ohio region, experienced an increase in sales of $142.5 million, added 1,276 jobs, saw an increase in labor income of $150.4 million, and increased value added by $73.9 million. Accounting for the whole state of Ohio, additional taxes from NASA Glenn operation in FY 2009 increased by $14.7 million compared to Northeast Ohio.

Since major Glenn expenditures elsewhere in the state of Ohio mirrored expenditures in Northeast Ohio, industries across Ohio that derive the most benefit from Glenn spending and spending by NASA Glenn employees and other workers are similar to those reported for Northeast Ohio.[29]

[29] A close examination of the IMPLAN results show that a few industry sectors have slightly higher values for the direct impact for Northeast Ohio than for the state of Ohio. The reason for this is the distribution of disposable income (Glenn payroll) by IMPLAN to those industries from which households typically make purchases. When making this distribution for the state of Ohio, IMPLAN assumes that households have the same distribution as the population across the state. Persons living in the Appalachian area of southeast Ohio or the farming regions of western Ohio do not have the same spending patterns as their counterparts in Greater Cleveland. For example, persons living in Appalachia do not spend as much on the arts and financial services as people living in suburban Cleveland. The IMPLAN results simply reflect this reality.

E. Comparison of NASA Glenn Economic Impacts in FY 2008 and FY 2009

NASA Glenn continues to be an important economic player in Northeast Ohio and across the state (Table 15). The economic impact in FY 2009 was greater than the economic impact in FY 2008 for all measures. NASA Glenn generated nearly 8,300 jobs in Ohio in FY 2009 compared to 7,600 in the previous year (a 9.1% increase). Output impact on the state was $1.36 billion in FY 2009 (13.6% higher compared to FY 2008), while household earnings increased by $495 million in FY 2009 as a result of NASA Glenn activities (24.9% higher than in the previous year).

Table 15. NASA Glenn Economic Impacts, FY 2008- FY 2009

Economic Impact	Northeast Ohio		State of Ohio	
	FY 2008	FY 2009	FY 2008	FY 2009
Output	$1,041.3 million*	$1,213.2 million	$1,193.8 million	$1,355.7 million
Value Added		$568.2 million		$642.1 million
Employment	6,225 jobs	7,017 jobs	7,599 jobs	8,293 jobs
Labor Income	$339.7 million	$344.4 million	$396.3 million	$494.8 million
Taxes		$87.5 million		$102.2 million

** Monetary values are adjusted to $2009 for comparison. Due to deflation in Northeast Ohio between 2008 and 2009, these values are lower than nominal $2008 dollar values.*

In Northeast Ohio, NASA Glenn output impact in FY 2009 was higher by $171.9 million (16.5%) compared to FY 2008. Glenn also generated 7,017 jobs in Northeast Ohio in FY 2009 compared to 6,225 jobs in FY 2008 (a 13% increase). In addition, the labor income impact in Northeast Ohio in FY 2009 was higher by $4.7 million (a 1.4% increase) compared to FY 2008. In this current report, we were able to calculate additional impacts for value added (output less intermediary goods and services) and taxes generated due to FY 2009 NASA Glenn operation. The large economic impact on the state and regional economies emphasizes the importance of NASA Glenn's activities and jobs in the region and the state.

NASA Glenn continues to be one of the major economic anchors of Northeast Ohio and a crucial part of the region's intellectual infrastructure. It is an invaluable asset for Northeast Ohio as the region struggles to restructure and transform its economy by attracting knowledge-based, research-intensive businesses and organizations. NASA Glenn is a positive presence in Northeast Ohio and serves as a magnet for many types of businesses and start-up companies based on innovation. NASA Glenn's employees are part of the region's knowledge-intensive labor force with unique cutting-edge skills in science and technology and the potential to generate wealth in the region.

APPENDIX A: DATA TABLES

Table A.1 Glenn Spending by State, FY 2009

Table A.2 Glenn Monies Allocated to Academic Institutions, FY 2009

Table A.3 NASA Glenn Detailed Expenditures in Northeast Ohio, FY 2009

Table A.4 NASA Glenn Detailed Expenditures in the State of Ohio, FY 2009

Table A.1. Glenn Spending by State, FY 2009

State	Spending	Share
Ohio	$326,444,684	60.32%
California	$40,806,576	7.54%
Maryland	$31,925,552	5.90%
Oklahoma	$23,420,300	4.33%
Virginia	$12,350,420	2.28%
Massachusetts	$11,501,158	2.13%
Florida	$9,242,615	1.71%
New York	$8,894,900	1.64%
Colorado	$6,929,896	1.28%
Pennsylvania	$6,705,290	1.24%
Connecticut	$5,858,066	1.08%
Illinois	$5,458,024	1.01%
Missouri	$5,177,157	0.96%
New Jersey	$4,944,272	0.91%
Arizona	$4,549,554	0.84%
Nevada	$4,505,167	0.83%
Texas	$3,433,250	0.63%
Washington DC	$3,374,127	0.62%
Michigan	$2,874,911	0.53%
Georgia	$2,864,315	0.53%
Washington	$2,536,457	0.47%
Indiana	$2,121,387	0.39%
New Hampshire	$1,810,775	0.33%
Alabama	$1,538,545	0.28%
Tennessee	$1,210,140	0.22%
Minnesota	$1,044,082	0.19%
New Mexico	$1,019,100	0.19%
North Carolina	$846,871	0.16%
Oregon	$816,546	0.15%
Wisconsin	$647,250	0.12%
Utah	$584,045	0.11%

Kentucky	$518,145	0.10%
Iowa	$447,034	0.08%
Arkansas	$443,294	0.08%
West Virginia	$426,997	0.08%
Rhode Island	$423,170	0.08%
Vermont	$345,219	0.06%
Delaware	$338,169	0.06%
Louisiana	$276,664	0.05%
Mississippi	$269,477	0.05%
Idaho	$258,097	0.05%
Kansas	$256,495	0.05%
Wyoming	$146,787	0.03%
South Carolina	$73,484	0.01%
Hawaii	$25,571	0.005%
Montana	$14,954	0.003%
Maine	$11,944	0.002%
Nebraska	$4,872	0.001%
North Dakota	$114	0.00%
Alaska	$104	0.00%
Outside U.S.	$1,443,486	0.27%
Total	**$541,159,506**	**100.00%**

Table A.2. Glenn Funding Allocated to Academic Institutions by State, FY 2009

State	Amount	Share
Maryland	$7,990,691	22.97%
Ohio	$7,964,886	22.90%
California	$3,986,538	11.46%
Georgia	$2,280,370	6.56%
Massachusetts	$2,264,177	6.51%
Virginia	$1,404,752	4.04%
Florida	$900,978	2.59%
Pennsylvania	$868,708	2.50%
Indiana	$790,395	2.27%
Tennessee	$675,557	1.94%
Illinois	$651,118	1.87%
Kentucky	$447,427	1.29%
Puerto Rico	$432,327	1.24%
New Jersey	$425,564	1.22%
New York	$294,411	0.85%
Arizona	$278,303	0.80%
Rhode Island	$275,608	0.79%
Louisiana	$263,727	0.76%
Minnesota	$260,514	0.75%
Alabama	$239,127	0.69%
Connecticut	$238,182	0.68%
Oregon	$234,526	0.67%
Iowa	$221,086	0.64%
Texas	$214,499	0.62%
North Carolina	$207,182	0.60%
Wisconsin	$194,955	0.56%
Michigan	$173,673	0.50%
Kansas	$167,331	0.48%
Missouri	$122,892	0.35%
Colorado	$109,490	0.31%
Delaware	$92,927	0.27%
Wyoming	$46,707	0.13%
Washington	$18,404	0.05%
Washington DC	$18,286	0.05%
Hawaii	$15,689	0.05%
Mississippi	$10,858	0.03%
Total	**$34,781,864**	**100.00%**

Table A.3. NASA Glenn Detailed Expenditures in Northeast Ohio, FY 2009

NAICS Sector	Description	IMPLAN Sector (a)	Expenditure (b)
Utilities			**$19,407,905**
	Electric power generation, transmission, and distribution	31	$16,965,774
	Natural gas distribution	32	$541,514
	Water, sewage and other treatment and delivery systems	33	$1,900,618
Construction			**$33,860,474**
	Maintenance and repair construction of nonresidential structures	39	$33,860,474
Manufacturing			**$4,929,547**
	Printing	113	$110,878
	Petroleum lubricating oil and grease manufacturing	118	$192,188
	All other petroleum and coal products manufacturing	119	$8,060
	Industrial gas manufacturing	121	$14,189
	Paint and coating manufacturing	136	$190
	All other chemical product and preparation manufacturing	141	$1,334
	Other rubber product manufacturing	152	$16,860
	Flat glass manufacturing	156	$3,783
	Other pressed and blown glass and glassware manufacturing	157	$5,585
	Primary smelting and refining of nonferrous metal (except copper and aluminum)	176	$12
	Copper rolling, drawing, extruding and alloying	177	$11,314
	Hardware manufacturing	193	$23,751
	Spring and wire product manufacturing	194	$3,846
	Machine shops	195	$27,538
	Valve and fittings other than plumbing manufacturing	198	$101,129
	Other fabricated metal manufacturing	202	$38,601
	Other industrial machinery manufacturing	207	$206,196
	Optical instrument and lens manufacturing	211	$600
	Heating equipment (except warm air furnaces) manufacturing	215	$19,735
	Air conditioning, refrigeration, and warm air heating equipment manufacturing	216	$6,997
	Pump and pumping equipment manufacturing	226	$18,018
	Fluid power process machinery manufacturing	233	$225
	Broadcast and wireless communications equipment manufacturing	238	$3,780
	Other communications equipment manufacturing	239	$36,639
	Audio and video equipment manufacturing	240	-$366
	Bare printed circuit board manufacturing	242	$274,914
	Industrial process variable instruments manufacturing	251	$60,795
	Electricity and signal testing instruments manufacturing	253	$32,018
	Analytical laboratory instrument manufacturing	254	$25,935

	Watch, clock, and other measuring and controlling device manufacturing	256	$21,747
	Software, audio, and video media for reproduction	257	$9,000
	Motor and generator manufacturing	267	$6,508
	Carbon and graphite product manufacturing	274	$59,996
	All other miscellaneous electrical equipment and component manufacturing	275	$7,688
	Guided missile and space vehicle manufacturing	287	$3,347,170
	All other miscellaneous manufacturing	317	$232,695
Wholesale & Retail Trade			**$5,664**
	Wholesale trade businesses	319	$5,664
Transportation			**$57,757**
	Transport by truck	335	$57,757
Information & Telecommunication			**$15,266,887**
	Software publishers	345	$17,172
	Telecommunications	351	$12,266
	Other information services	353	$15,237,450
Real Estate and Rental & Leasing			**$422,691**
	Commercial and industrial machinery and equipment rental and leasing	365	$422,691
Professional, Scientific, & Technical Services			**$136,623,627**
	Legal services	367	$188,181
	Accounting, tax preparation, bookkeeping, and payroll services	368	$10,800
	Architectural, engineering, and related services	369	$2,678,625
	Custom computer programming services	371	$12,000
	Other computer related services, including facilities management	373	$4,256,432
	Management, scientific, and technical consulting services	374	$20,855
	Scientific research and development services	376	$101,308,460
	All other miscellaneous professional, scientific, and technical services	380	$28,148,273
Administrative & Support and Waste Management Services			**$40,840,078**
	Facilities support services	385	$16,462,723
	Business support services	386	$24,375,356
	Services to buildings and dwellings	388	$2,000
Education			**$3,549,597**
	Private junior colleges, colleges, universities, and professional schools	392	$3,549,597
Health Care & Social Assistance			**$1,320,614**
	Medical and diagnostic labs and outpatient and other ambulatory care services	396	$1,320,614
Repair & Maintenance			**$21,613**
	Commercial and industrial machinery and equipment repair and maintenance	417	$21,613

Other Services			**$2,052**
	Civic, social, professional, and similar organizations	425	$2,052
Government Enterprise			**$259**
	Other state and local government enterprises	432	$259
Household			**$183,716,770**
	Household spending (c)	10001-10009	$183,716,770
TOTAL EXPENDITURES in NEO			**$441,751,294**

a. Sector: Industry classification code used by IMPLAN. It is analogous to the North American Industry Classification System (NAICS). IMPLAN provides a cross-reference table bridging their sector numbers and NAICS codes.

b. Expenditure: Actual dollar value for a product or service spent by NASA Glenn Research Center (Glenn) in FY 2009. Values shown in Table A-3 are limited to expenditures made in Northeast Ohio.

c. Households: Household expenditures include Glenn employee payroll and medical insurance. Payments have been reduced to include only disposable income. In this analysis, disposable income equals the gross amount and medical benefits. Disposable income excludes income that is used for savings and to pay taxes.

Table A.4. NASA Glenn Detailed Expenditures in the State of Ohio, FY 2009

NAICS Sector	Description	IMPLAN Sector (a)	Expenditure (b)
Utilities			**$19,485,702**
	Electric power generation, transmission, and distribution	31	$16,965,774
	Natural gas distribution	32	$541,514
	Water, sewage and other treatment and delivery systems	33	$1,978,415
Construction			**$35,578,128**
	Maintenance and repair construction of nonresidential structures	39	$35,578,128
Manufacturing			**$6,347,369**
	Footwear manufacturing	93	$19,162
	Printing	113	$110,989
	Petroleum lubricating oil and grease manufacturing	118	$192,188
	All other petroleum and coal products manufacturing	119	$8,060
	Industrial gas manufacturing	121	$14,189
	Paint and coating manufacturing	136	$190
	All other chemical product and preparation manufacturing	141	$13,466
	Other rubber product manufacturing	152	$16,860
	Flat glass manufacturing	156	$3,783
	Other pressed and blown glass and glassware manufacturing	157	$5,585
	Steel product manufacturing from purchased steel	171	$28,080
	Primary smelting and refining of nonferrous metal (except copper and aluminum)	176	$12
	Copper rolling, drawing, extruding and alloying	177	$11,314
	All other forging, stamping, and sintering	181	$0
	Hardware manufacturing	193	$23,751
	Spring and wire product manufacturing	194	$3,846
	Machine shops	195	$54,441
	Valve and fittings other than plumbing manufacturing	198	$135,849
	Plumbing fixture fitting and trim manufacturing	199	$9,817
	Other fabricated metal manufacturing	202	$149,971
	Lawn and garden equipment manufacturing	204	$9,491
	Other industrial machinery manufacturing	207	$484,534
	Optical instrument and lens manufacturing	211	$600
	Heating equipment (except warm air furnaces) manufacturing	215	$19,735
	Air conditioning, refrigeration, and warm air heating equipment manufacturing	216	$39,047
	Cutting tool and machine tool accessory manufacturing	220	$6,755
	Pump and pumping equipment manufacturing	226	$67,057
	Air and gas compressor manufacturing	227	$11,622
	Other general purpose machinery manufacturing	230	$27,349
	Fluid power process machinery manufacturing	233	$225
	Broadcast and wireless communications equipment manufacturing	238	$3,780

	Other communications equipment manufacturing	239	$36,639
	Audio and video equipment manufacturing	240	-$366
	Bare printed circuit board manufacturing	242	$274,914
	Other electronic component manufacturing	247	$1,798
	Industrial process variable instruments manufacturing	251	$74,011
	Electricity and signal testing instruments manufacturing	253	$50,002
	Analytical laboratory instrument manufacturing	254	$45,312
	Watch, clock, and other measuring and controlling device manufacturing	256	$62,311
	Software, audio, and video media for reproduction	257	$9,000
	Small electric appliance manufacturing	261	$3,604
	Motor and generator manufacturing	267	$6,508
	Carbon and graphite product manufacturing	274	$275,186
	All other miscellaneous electrical equipment and component manufacturing	275	$66,083
	Light truck and utility vehicle manufacturing	277	$31,699
	Other aircraft parts and auxiliary equipment manufacturing	286	$116,777
	Guided missile and space vehicle manufacturing	287	$3,376,170
	All other transportation equipment manufacturing	294	$203,062
	Office furniture and custom architectural wood work and mill work manufacturing	301	$9,848
	Office supplies (except paper) manufacturing	313	$366
	All other miscellaneous manufacturing	317	$232,695
Wholesale & Retail Trade			**$81,996**
	Wholesale trade businesses	319	$81,996
Transportation			**$92,694**
	Water transportation	334	$30,000
	Transport by truck	335	$62,694
Information & Telecommunication			**$15,305,543**
	Directory, mailing list, and other publishers	344	$3,779
	Software publishers	345	$17,167
	Telecommunications	351	$47,148
	Other information services	353	$15,237,450
Real Estate and Rental & Leasing			**$422,691**
	Commercial and industrial machinery and equipment rental and leasing	365	$422,691
Professional, Scientific, & Technical Services			**$190,830,598**
	Legal services	367	$197,589
	Accounting, tax preparation, bookkeeping, and payroll services	368	$10,800
	Architectural, engineering, and related services	369	$4,069,597
	Custom computer programming services	371	$51,515
	Other computer related services, including facilities management	373	$4,323,845
	Management, scientific, and technical consulting services	374	$20,855
	Scientific research and development services	376	$142,826,416
	All other miscellaneous professional, scientific, and technical	380	$39,329,982

	services		
Administrative & Support and Waste Management Services			**$46,632,604**
	Facilities support services	385	$16,462,723
	Business support services	386	$24,375,356
	Investigation and security services	387	$5,792,526
	Services to buildings and dwellings	388	$2,000
Education			**$8,109,271**
	Private junior colleges, colleges, universities, and professional schools	392	$8,109,271
Health Care & Social Assistance			**$1,320,614**
	Medical and diagnostic labs and outpatient and other ambulatory care services	396	$1,320,614
Repair & Maintenance			**$21,613**
	Commercial and industrial machinery and equipment repair and maintenance	417	$21,613
Other Services			**$6,427**
	Civic, social, professional, and similar organizations	425	$6,427
Government Enterprise			**$54,323**
	Other Federal Government enterprises	429	$47,824
	Other state and local government enterprises	432	$6,499
Household			**$183,716,770**
	Household spending (c)	10001-10009	$183,716,770
TOTAL EXPENDITURES in Ohio			**$510,161,454**

a. Sector: Industry classification code used by IMPLAN. It is analogous to the North American Industry Classification System (NAICS). IMPLAN provides a cross-reference table bridging their sector numbers and NAICS codes.

b. Expenditure: Actual dollar value for a product or service spent by NASA Glenn Research Center (Glenn) in FY 2009. Values shown in Table A-4 are limited to expenditures made in Ohio.

c. Households: Household expenditures include Glenn employee payroll and medical insurance. Payments have been reduced to include only disposable income. In this analysis, disposable income equals the gross amount and medical benefits. Disposable income excludes income that is used for savings and to pay taxes.